Railway Electrical Engineer

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Railway Electrical Engineer

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1924 and 1925

During 1924 orders were placed in the United States for 2,554 passenger cars. A total of 2,213 cars were built during the year. Practically all of these cars will be equipped with electric lights. In order to meet the demands for improved lighting, dependability and low cost, the car lighting engineers have given their attention to special axle pulleys, the extended use of type C lamps, hard rubber jars for lead batteries with increased sediment space and the use of head-end lighting for suburban trains both with and without batteries.

Locomotive orders for the year totaled 1,413. All of these locomotives will be equipped with electric headlights and at some later date, if not immediately, many of them may be fitted with train control apparatus. This situation has introduced a headlight generator problem which must be given consideration if energy for train control is to be obtained from the headlight generator or another turbine driven machine. The outstanding development pertaining to train control for the year has been the insertion of the provision for the permissive feature of the train stop in the I. C. C. specifications. This and several new interpretations of the commission's order have necessitated intensive development on the part of the manufacturers. Of the 46 roads on which the first order is now effective in requiring a complete engine division to be equipped by January 1, 1925, all but four have announced their selection of a system or device.

Machine tool orders for the year totaled about $14,000,000. By far, the greater part of the machines represented in these orders are motor driven and there is evident an increasing demand for push-button or automatic control. Lighting in railroad shops and even in engine-houses seems to be approaching a standard in which the R. L. M. and angle type enameled reflectors are used most extensively. For yard lighting floodlights are being favored.

According to recently compiled statistics the number of welding sets in use on the railroads has increased about nine per cent during the past year. The use of welding is becoming stabilized and users are getting acquainted with its possibilities and limitations. The outstanding development in the welding field during the year was work done by the welders in the fabrication of steel structures. Up-to-date this work has been limited to small buildings but indications are that welding in the structural field will be extended, adopted and standardized as it has been in repair work and in manufacturing.

Railroad power plants with a few notable exceptions lag behind other railroad development. The railroads are using an ever increasing amount of electric power and utility companies are constantly improving their ability to supply cheap and dependable power. The result is that more power is purchased than in past years. This fact should not be accepted as a criterion, however, as circumstances in railroad terminals are often such as to make an efficient power plant more desirable than purchased power.

Much progress has been made recently with motor rail cars. An outstanding development of especial interest to the electrical men is the return of the gas-electric car. The complications of the early gas-electric cars have been disposed of and their dependability greatly increased. This car will probably find a place where the amount of travel is moderate rather than light, where a high grade of service is required and where multiple-unit operation is desirable.

The oil-electric locomotive was introduced to the railroad field this year. In its present state of development it is a machine capable of developing relatively small power but it has the ability to use all of this power at any speed. For this reason and because of its remarkable fuel economy it ought to comply well with general switching requirements. Increasing the power of the locomotive would mean using more than one engine or the development of a larger engine.

Only 18 electric locomotives appear on the list of locomotives ordered this year by railroads in this country, but this fact does not mean that electric traction development has been at all retarded. The electric zones were extended on five different railroads and 12 new locomotives were placed in service by the New Haven, 3 by the Pennsylvania and 4 by the Norfolk & Western while 12 are being built for the Virginian. The Baltimore & Ohio has started the electrification of its Ft. George-Tottenville line on Staten Island, N. Y., the work on the Virginian electrification is approaching completion, and the Great Northern has announced that it will electrify 80 miles of line. Orders have been placed for 80 motor cars by the Staten Island lines of the Baltimore & Ohio; the New York, New Haven & Hartford ordered 3, the New York, Westchester & Boston 10, and 120 motor cars and 85 trail cars were ordered by the Illinois Central.

Innovations in the electric traction field this year are the motor-generator locomotive for the Detroit & Ironton and the 3,000-volt motor car built by the General Electric Company. Seven of the locomotives ordered this year were also motor-generator locomotives for the New Haven. The electrical equipment for the D. & I. locomotives was supplied by the Westinghouse Electric &

Manufacturing Company and the New Haven locomotives will be built by the General Electric Company.

What will be done this year in the electric traction field is probably dependent upon the financial condition of the railroads. In this connection it can be said that most of the changes made in dividend rates on railway stocks during 1924 were increases. The feature of the year was the number of carriers which declared initial dividends on their common or preferred issues. As long as traffic continues to increase and financial conditions to improve increased activity in the electric traction field is assured.

Rail Motor Car Maintenance

With the constantly increasing use of rail motor cars on nearly all of the railroads, there is bound to come the problem of the maintenance of this equipment. The question that naturally arises is whether it is better to bring in men from the automobile industries to take care of this work or to train the regular railway mechanics to look after this equipment. Undoubtedly there are arguments in favor of each method. Yet when all is said and done the first-class mechanic should be able to give just as good an account of himself with rail motor cars as with locomotives, providing, of course, he has been given an opportunity to learn something about this equipment. The maintainer's job is to repair and replace such parts as have become worn out or broken in service and so far as the field of the mechanic is concerned it does not seem that this presents a very much different problem from that which he is accustomed to in the maintenance of any mechanical device.

As the number of rail motor cars increases it will probably develop that shops for their up-keep will have to be organized at points most convenient to the service and as the number of mechanics engaged in this work increases there does not seem to be any good reason why such a force should not be built up from those who are at present working on locomotive and car repairs. There are plenty of good railway mechanics who are capable of doing work of this kind and it seems only fair that they should be given an opportunity to prove their ability.

Letter to the Editor

Rubber Varnish for Battery Trays

MILWAUKEE, WIS.

TO THE EDITOR:

The practice of paraffining lead storage battery trays as recommended by the Association of Railway Electrical Engineers is without question a good way to preserve the wood, but it may not always be the best practice. The labor and equipment costs for paraffining any great number of trays are considerable and no doubt there are places on the different railroad systems where this equipment is not supplied and where crates are put in service without adequate treatment.

It has been the experience of the Newport Company that a treatment of wood with Para quick drying varnish is fully as good, if not better than paraffine where the wood is exposed to acids or alkalies. In reality this is a liquid rubber which can be brushed on and dries very quickly, leaving a slight impregnation of clear rubber. This same material can also be used to coat over clean metal surfaces to prevent corrosion.

My experience with the varnish has been confined to uses in chemical work, but under conditions where the wood is subjected to considerably harder service from the acid standpoint than battery trays used in railroad work. The compound is applied to the wood by brushing it on with a paint brush so that the matter of applying the varnish is a simple painting job. The wood must be dry when the varnish is applied and two coats are desirable. The varnish is applied as received and will be dry if done in a warm room at a temperature of about 70 degrees Fahrenheit, within 30 to 40 minutes ready for use. It has been my experience that the first coating is sufficient for the life of the wood as after any wood has been exposed to acid to any extent and the acid has time to work itself into any unfilled pores of the wood, it is not possible to draw the acid out of the pores and again replace it with any neutral substance. This is because the acid destroys the resinous compound of the wood so that the wood fibre will swell when moist and disintegrate when allowed to dry out.

Whether or not the Para rubber has ever been used in connection with train lighting batteries, I do not know, but I feel certain that it would be well worth while trying out as it has served to protect wood from acids and alkalies under much more severe service conditions.

J. H. WICKMAN, Mechanical Engineer,
The Newport Company.

New Books

Dynamo Electric Machinery by Erich Housmann, E.E., 645 pages, 447 illustrations, 6 in. by 8¾ in., bound in cloth, published by D. Van Nostrand, price $4.50.

This book supplants two volumes on direct and alternating current machinery written jointly with the late Dr. Samuel Sheldon. It is rigorous in its treatment of the subject and employs calculus and trigonometric functions extensively in working out many of the fundamental concepts. The book contains fourteen chapters and presents the theory, construction and operation of direct and alternating current machinery in a very thorough manner.

While there is no question but that the author had the class-room student in mind in the preparation of the book, there are some parts which will undoubtedly be found of value to others, although an excellent grasp of higher mathematics is essential before one can derive the full benefits from the wealth of the material which the book contains.

Railway Electrification by H. F. Trewman, assistant professor of electrical engineering Artillery College, Woolwich, England, 239 pages, illustrated, diagrams and tables, 5½ in. by 8½ in. Bound in cloth. Published by Sir Isaac Pitman & Sons, Ltd., London. Price $7.50.

The subject matter of the book is divided into ten chapters which treat of the generation, transmission and distribution of electrical energy. Electric traction motors, the energy required to move trains and the estimation of the weight of equipment required for a given service, are given. One chapter is devoted to the economics of suburban electric trains and another to consideration of trunk line service. Throughout the book are given many tables, diagrams and formulae. For the most part, the illustrations chosen show English and European practices rather than those which are to be found in America.

One of the new New York Central Diners Equipped with a 4 kw. Generator and a 300 amp. hr. 64-volt Battery

New Diners for the New York Central Lines

Individual Control of Lights and Fans Is a Feature of the Electrical Installation

TWENTY-EIGHT dining cars have recently been placed in service on the New York Central lines which have exceptionally complete electrical facilities. An unusual feature of the wiring is that there is a separate switch for each lighting outlet and fan. Most of these switches are contained in four switch cabinets located at different points in the car. The many switches make it possible to use the lights and fans as they may be needed and to avoid unnecessary drain on the battery. This is particularly desirable when meals are not being served but there is silver to be cleaned or other work to be done in the kitchen. The interior of the car is finished in mahogany with a gray enameled ceiling. Fans and lighting fixtures are maroon. Enclosed bowl type reflectors are used over the center aisle of the car and double bracket side lights between windows. Thermostats and

Double Bracket Side Lamps and Ceiling Lights Mounted on a Pearl Gray Ceiling Provide Abundant Illumination

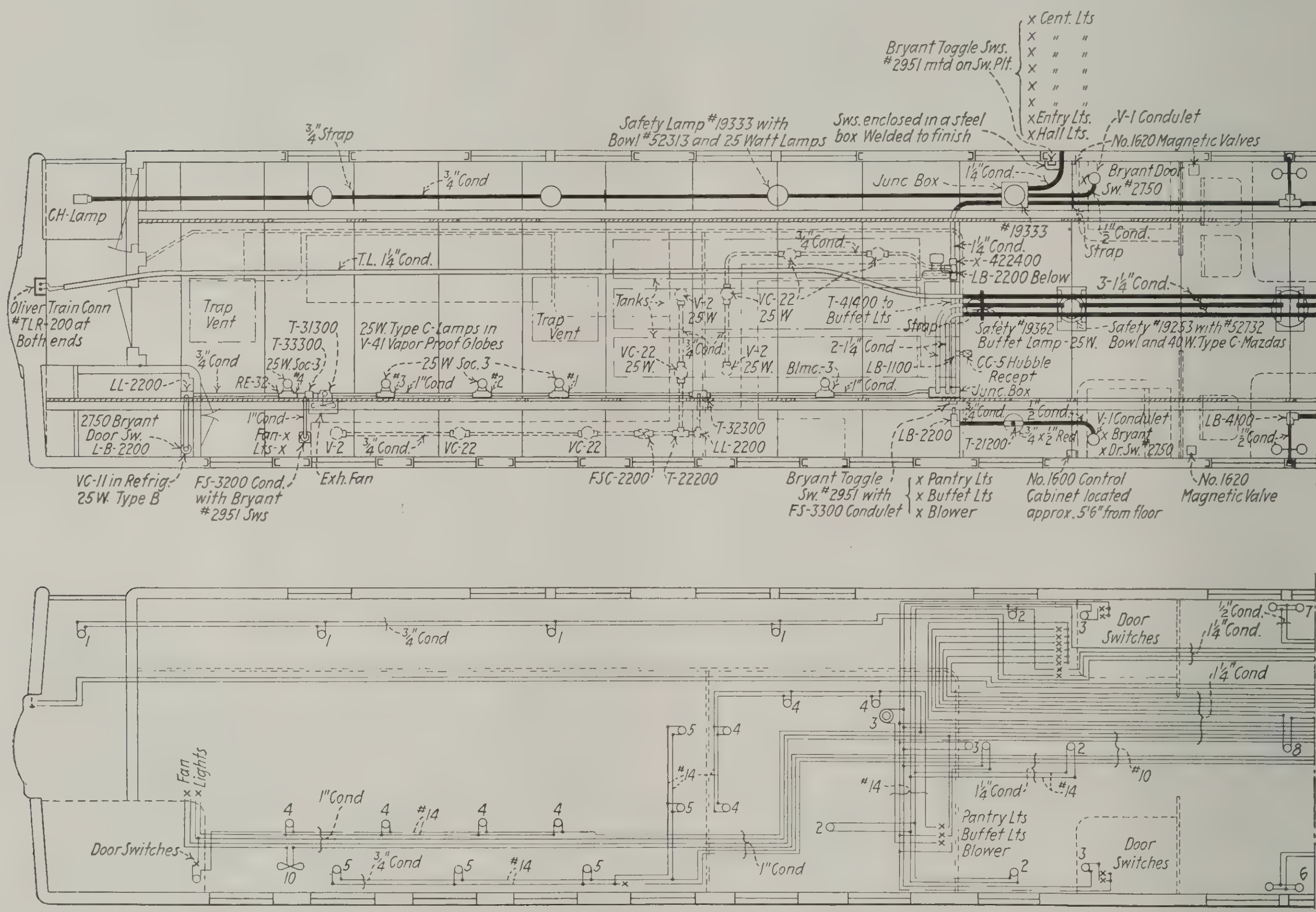
The Kitchen Is Equipped with General and Local Lighting, Door Operated Ice Box Lights and Two Ventilating Fans

electro-magnetic steam valves are used to maintain an even temperature in the cars during cold weather. Ceiling fans are used in hot weather and the kitchen is provided with exhaust fans. Sixty four-volt equipment is used.

The cars were built to New York Central specifications by the Pullman Company. Sixteen are being used by the New York Central, three by the Michigan Central, three by the Boston & Albany, one by the Pittsburgh and Lake Erie and five by the Big Four. All of the cars except those used on the Big Four are equipped with Gould truck mounted generators. Safety body hung machines

In all cases a 19-in. axle pulley with a 10-in. face is used, mounted on the axle with a corrugated steel bushing. For body hung machines the axle pulley is provided with a 2-in. flared flange and for truck mounted machines the pulley has a 1-in. straight flange.

Flexible generator leads protected by canvas hose are run from the generator to a terminal block mounted on the center sill. All other wiring in the car is double braid, rubber covered, 30 per cent wire carried in rigid metal conduit. From the terminal block the generator leads are carried through 1¼-in. conduit to a large junction box. From this box leads are run to the switchboard



The Upper Diagram Is a Plan of All of the Conduit and Fittings in the Car Above the Floor Line.

are used on the Big Four Cars. Putnam lead batteries are used with Safety equipment and Gould lead batteries are used on all the rest except for the Boston & Albany cars which have Edison batteries.

Equipment

The generator which is a 4 kw. machine is located under the dining end of the car. Truck hung machines have a 12½-in. pulley with an 8½-in. face and the center line of the pulleys is 10½-in. from the center line of the car. The generator is supported by a four-point link type suspension having forged support bars. All wearing parts of the suspension are bushed.

Body hung generators are equipped with an 8-in. generator pulley having an 8½-in. face mounted so that the center line of the pulley is 8 in. from the center line of the car. Angle supports and safety chains are provided for the generator.

and regulator locker located in the dining end of the car, to the batteries, to two charging receptacles, one on each side of the car, and to the thermostat and magnetic control valves.

The switchboard and regulator cabinet is 24 in. wide by 12 in. deep and extends from the floor of the car to the deck sill. It contains the generator regulator, lamp regulator, a ten-circuit distribution panel and five fan switches and resistances. The cabinet is ventilated by perforations in the door and by a duct extending from the top of the locker to the outside of the car. All ventilating holes are covered with fine mesh copper screen which can be removed for cleaning. An inspection record card holder large enough to accommodate a card 6 in. wide and 8 in. high is mounted inside on the locker door. Provision is made for the possible addition of an ampere hour meter in the battery circuit. This is accomplished by running one battery lead directly to the regulator panel

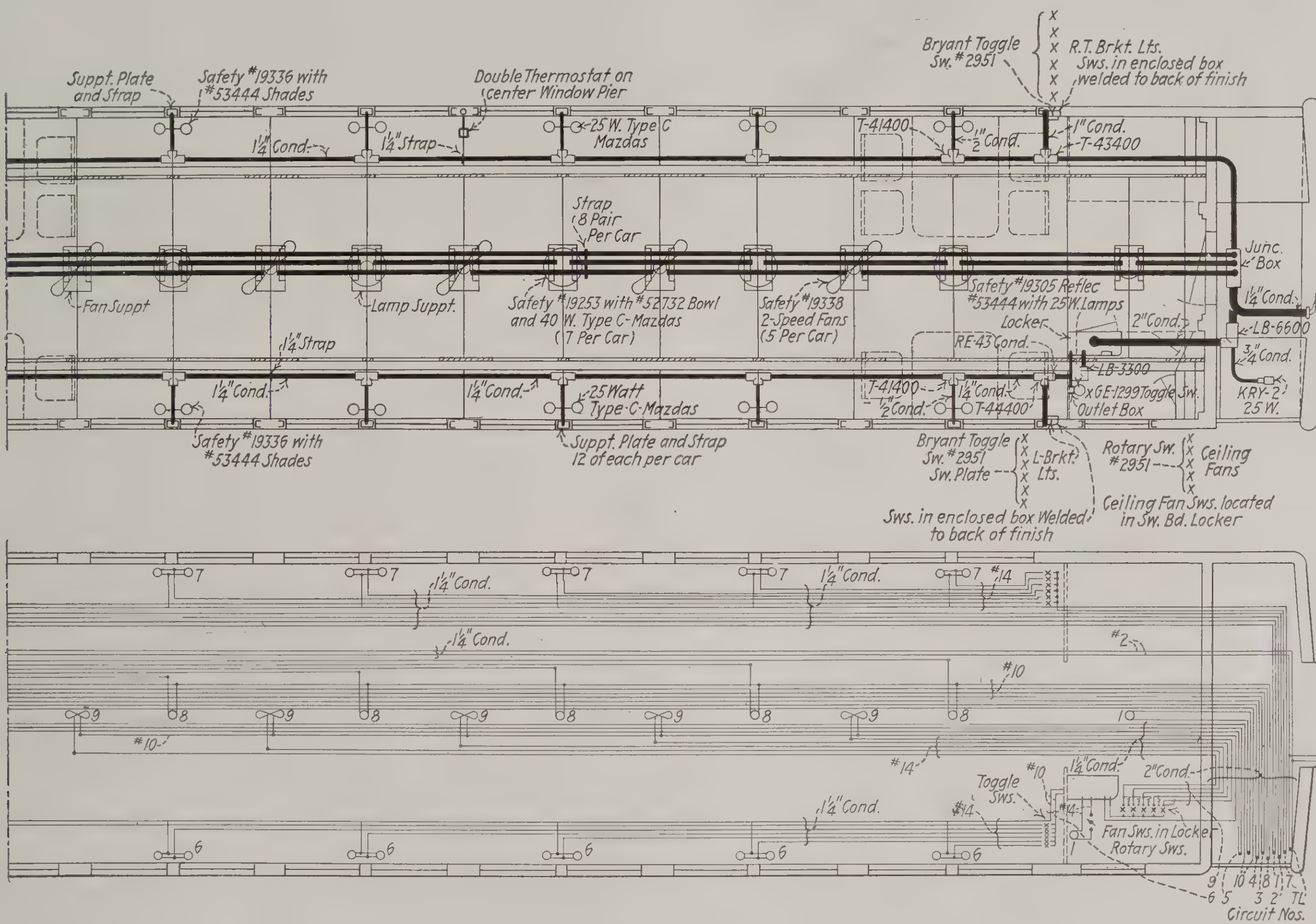
without a splice and a return wire to the junction, making one extra run of wire between the junction box and regulator.

Batteries

The lead batteries are all 300 amp. hr. Plante type batteries and consist of 32 cells arranged in 16 two-cell trays. One tray in each battery box is fitted with a record plate. Rubber jars are used with rubber covers and rubber separators. The batteries are carried in four battery boxes with four trays in each box. The top and bottom of each box is made of ⅛-in. steel plate and the bottom is covered with ¼-in. bitumastic compound

flat steel hangers 2½ in. by ¾ in. A flanged connection bracket 5/16 in. thick is riveted to each of the two hangers at such a height as to take the diagonal braces to the center sill. The upper end of the flat steel hangers are bent to hook over two 3 in. by 3 in. by ⅜ in. rolled steel support angles which extend from the side sill angle to the center sill web. The braces which extend from the flange on the hangers to the botton of the center sill are made of 2 in. by 2 in. by 5/16 in. angle.

The charging receptacles are Anderson type C, in cast iron swivel brackets located near the transverse center line of the car with the face of the cover in closed position



The Lower Diagram Shows the Wiring in This Conduit with Switches and Outlets

and a 1-in. wood floor. The ends of the box are made of 1/16-in. steel reinforced with 1 5/16-in. wood and the back of the box is 1 5/16-in. wood without steel. The door is made of 1/16-in. steel reinforced with 15/16-in. wood. The door is removable and is also hinged in the center so that the upper half of the door may be dropped down for flushing or inspection. There are two handles on the top section of the door and S hooks with chains attached are anchored to the ends of the box for both the top and bottom sections of the door. The inside depth of the box from front to back is 2 ft. 1 7/16 in., the height is 2 ft. ¼ in. and the length is 3 ft. 9 ¼ in. The box is ventilated by four 2-in. holes in the back of the box near the top and four 2-in. holes in the bottom. These holes are covered with fine mesh copper screen.

The bottom supports of the box consist of two Z bars running lengthwise of the box supported at the ends by

4 in. in from the side of the car. This mounting is made uniform on all cars to facilitate yard charging.

Lighting and Wiring

In addition to the ceiling fan circuits, there are ten circuits carried out of the regulator and switchboard cabinet. There is also a circuit for the train line consisting of two No. 2 wires in a 1¼-in. conduit. The ten circuits are carried to three switch cabinets and to circuits controlled by condulet mounted switches in the kitchen and to automatic door switches in the ice boxes. Two of the switch cabinets are located at the dining end of the car and one is near the center. All conduit is concealed between the ceiling and the roof or in the side walls.

There are six toggle switches in each of the two cabinets near the end of the car and each one of the switches controls the two lights in one of the twelve double side bracket lights. There are eight switches in the locker near

the center of the car. Six of these switches control the six center lighting units in the dining compartment, one controls the upper pantry light and three upper buffet lights and one controls the lights in the hall and in the vestibule. Three condulet mounted switches in the pantry control the lower pantry lights, buffet light and blower fan respectively. Two condulet mounted switches in the kitchen control the exhaust fan and the kitchen lights.

Safety lighting fixtures are used throughout in the dining compartment and in the hall. The six center lights are enclosed bowl type fixtures and those in the hall are similar in design but smaller in size. The lamps used in the center lights are 40-watt lamps with a P S 20 bulb and those in the hall are 25-watt lamps with a P S 18 bulb. The bracket sidewall units have open end reflectors and are fitted with 25-watt, P S 18, bowl frosted lamps.

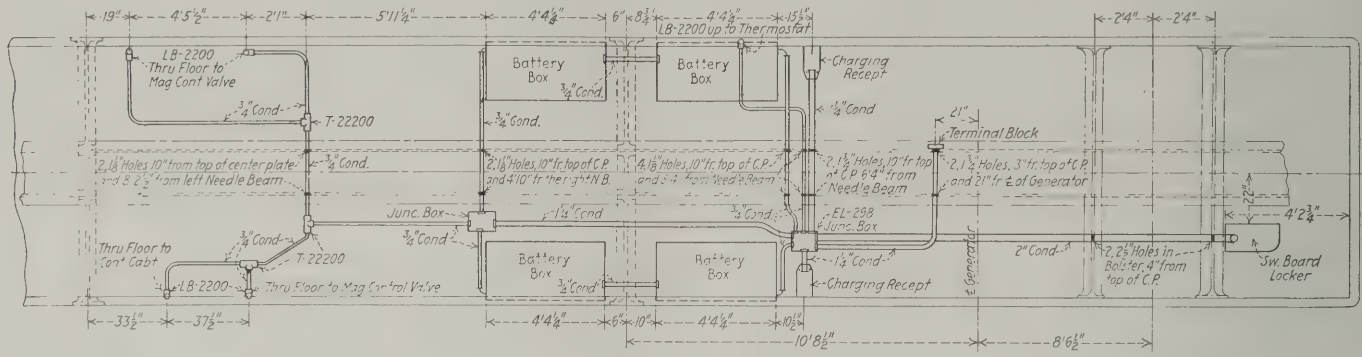
All lights in the pantry, kitchen and vestibules are 25 watt units. The lower lights in the kitchen, pantry and three ice boxes are Crouse Hinds vapor proof units while the upper kitchen and pantry lights are white porcelain enameled reflectors designed by the railroad and supported in type S O condulets. The vestibule lighting units are also porcelain enameled reflectors of New York Central design mounted so that the bell of the reflector is flush with the ceiling.

Fans

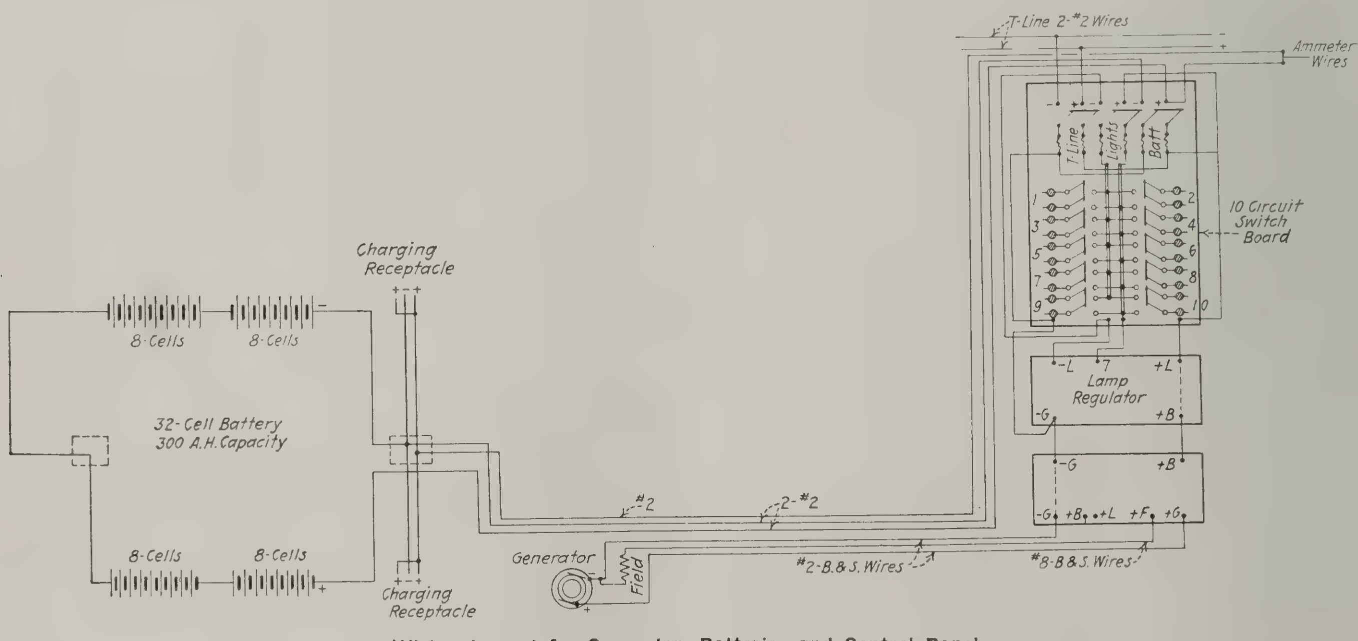
The five fans in the dining compartment are Safety six-blade ceiling fans with rotating air deflectors. They are controlled individually by five rotary switches located in the regulator and switchboard cabinet. The switches have three positions so that the fans can be run at full speed, at a reduced speed or turned off. Full speed of the fans is 730 r. p. m. and the reduced speed, which is effected by putting a twenty-ohm resistance in series with the fan, is 530 r. p. m. The flow of air from the fans is not steady, the arrangement of the deflector blades in two groups and the rotating speed of the deflector being such that a given point within a conical range receives an air movement about twenty times a minute when the fans are running at their maximum speed.

A Sirocco blower is located over the buffet which draws air from the dining-room through a duct opening over the buffet. The duct terminates in the kitchen through an opening in the deck plate molding between the broiler and the range. The opening in the deck plate is made larger than the duct so that air from the kitchen is exhausted through the opening by syphon action.

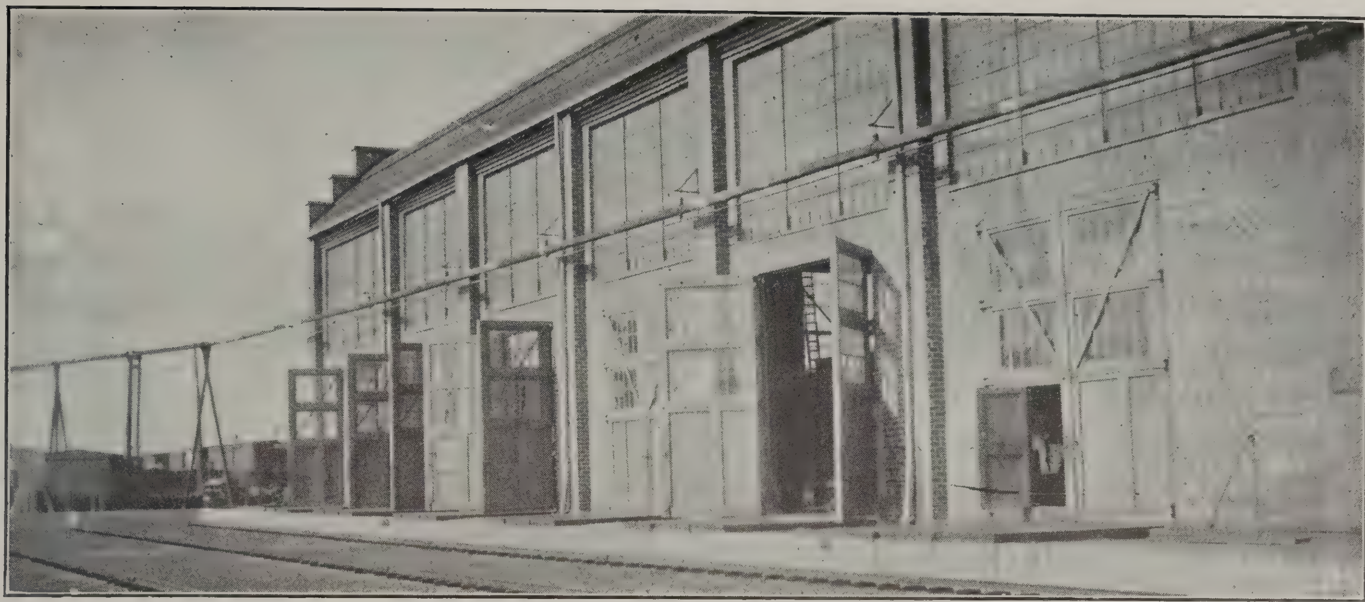
A Safety exhaust fan is located on the other side of the kitchen directly opposite the range and about three feet nearer the end of the car than the syphon exhaust.



Arrangement of Conduit Under the Floor of the Car. Terminal Block Is Shown in Position for Truck Mounted Generator



Wiring Layout for Generator, Batteries and Control Panel



New Back Shop on the N. Y. C. & St. L. at Stony Island

Nickel Plate Builds New Shop at Stony Island

More Extensive Use Made of Electrical Energy—Belt Driven Machines Converted to Individual Drive

By H. A. Leatherman

THE New York, Chicago and St. Louis Railroad has recently completed a new back shop at their Stony Island plant, which is the western terminus of the Nickel Plate district. The building is of steel skeleton construction, with hard brick finish, the fenestration is so generous indeed that the brick portion is hardly more than a trim. A general view of the building may be seen above. This photograph was taken from the west side of the building and shows the transfer table pit in the foreground. The steam line seen running along the outside is of passing interest because it is one of the very few steam power lines still remaining on the plant. It supplies steam for an old style engine which runs the wood mill, several hundred feet distant; this steam line is about to pass away with its companion the faithful old engine, as a motor installation has already been laid out to take its place.

The new building is about 80 by 180 feet in plan, and really has but three walls, the old back shop opening into the new and making possible the omission of the fourth end." Six locomotive pits are provided in the new shop, giving the combined old and new portions a total of 13 pits; part of the pits in the old portion of the shop have been given over to tank work, while all of the new pits are used for locomotive work as well as part of those in the old shop when occasion requires. The old portion of the shop is all that the name implies and the contrast between the old and new portions is a splendid example of the march of progress in industrial building construction, particularly as to light and ventilation.

The lighting is accomplished by twenty-four 300-watt "C" lamps utilized in 18-in, steel reflectors of the conventional RLM type, symmetrically spaced on the bottom of the roof trusses, these units are assisted by seven 100-watt lamps per side and two on the ends, placed in steel angle reflectors supported by conduit goose-necks at a distance of 15 ft. 6 in. from the floor, the large units are 40 ft. from the floor, a distance obviously great enough to permit the use of clear lamps without objectionable glare at the working plane. The layout of this lighting is shown in a slightly exaggerated scale in Fig. 1. Very little local lighting is necessary, nevertheless each machine on the floor is provided with a Hubbel receptacle located in a convenient place near the base of the machine. These receptacles are mounted on "E" condulets and the conduit is carried under the wood block floor and grouped on a circuit separate from the other lighting. Each machine operator is provided with a short drop cord or bracket fixture which may be plugged into these receptacles and in this way there are no cords strung about the machine side of the shop.

On the pit side of the shop the cords are run from the service pillars to the desired point. The service pillars are located between pits and near the ends, as reference to Fig. 1 will show. The service pillar, Fig. 2, is a ten foot post of 9-in. channel iron which is fitted up to supply compressed air, welding and lighting services. The 8-in. by 14-in. sheet steel box shown on the top of the pillar contains four single pole fuses placed in the "hot" side of the line, together with the necessary pipe fittings for the compressed air leads. It has been found that drop cord fuses blown were almost invariably

in the "hot" side of the line, and by grouping the fuses as shown, each drop cord has individual single-pole fuse protection as well as double pole protection for the circuit as a whole. This method was adopted to avoid delays to other workmen when some cord on the circuit developed a "short." The fuse box is a home-made job, the sides are one piece with a welded seam and the bottom another piece welded to the sides, the top is another piece, with the sides bent down to fit over the box, but not fastened. The whole is of 1/16 in. stock.

Lighting current is brought into the building by 115-230 volt mains separate from the power feeders, and distributed through dead front panel boxes located at the distribution center. As has been mentioned, the fenestration is so generous that under ordinary summer conditions no artificial illumination is necessary, and the shop has not yet been used in the long, dark afternoons of autumn, or for night work, so that the proof of the illumination pudding is not yet ready.

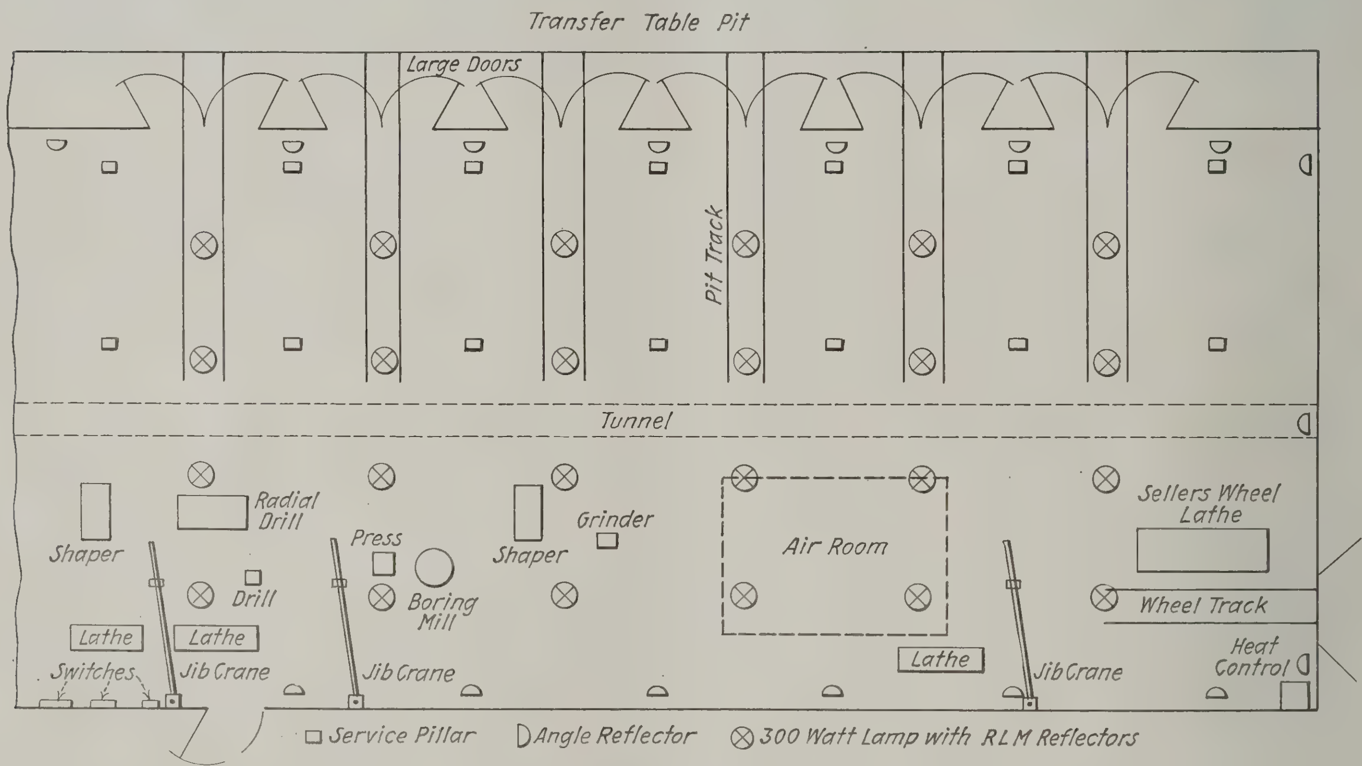


Fig. 1—Layout of Shop Showing Location of Tools and Other Facilities

The heating plant is a forced draft arrangement in which a series of steam coils is mounted before the intake of a large blower type fan. The fan is driven by a 15-hp. slip ring motor with Industrial Controller starting apparatus and speed control, the control apparatus being located on the side wall within easy reach of the floor while the motor and steam coils are mounted on a platform supported by the roof trusses, just over the Sellers wheel lathe, Fig. 1. The heated air is distributed throughout the building by sheet metal pipes run along the side of the building.

Two separate welding circuits are provided, one for machinist welders and one for boiler-maker welders, the receptacles for the one being painted red and the others black, alternate rows of service pillars having red or black receptacles. Anderson Type N 150-ampere receptacles are used. The welding circuits are run in a 2-in. conduit line in the "tunnel," which is a pit running the entire length of the shop and roofed over with heavy timber. It contains electric, air, water and steam conduits. The branch welding circuits are taken off in ¾ in. conduit which was run before the wood floor was laid.

The shop is served by a 15-ton Shaw crane equipped with 440-volt slip ring motors of 40 hp., 5 hp. and 40 hp. for the bridge, trolley and hoist, respectively. An incident in connection with the maintenance of this crane may be of interest. Users of this make of crane know the controllers use carbon brushes contacting with bronze contact plates or bars. Inexpert handling of the control levers caused a couple of the contact plate to become badly pitted and burned on one edge, with consequent arcing and unreliable operation. The maintenance man did the usual stunt of reversing the contact plates and thus presenting a new and unworn edge to the brush, but in a short time this side, too, became worn, and as no spare plates were on hand, he hit upon the idea of having the welder build up the worn edge with a little Tobin bronze. It required but a few minutes to deposit the metal and true up on the grinder and the job was so generally satisfactory that the practice has been followed extensively since, even to the repairing of K-type controller fingers on other machines.

Shortly after the crane was installed workmen complained of sparks occurring between the hook and various parts of locomotives on the floor. The alleged sparks and shocks never followed any particular law or regularity, but as the foreman put it, "sometimes did and sometimes didn't," even under apparently identical conditions. It was some time before the shop electrician actually witnessed the arcing because of the freakish irregularity of the occurrence.

Testing showed an extremely high resistance ground between the trolley wires and the crane frame, and even

when the different portions of the motor and control circuits were isolated to locate the ground, none of the individual portions of the circuit showed any evidence of ground, even with the "megger." But when the circuits were reconnected and the ground again showed up, it was thought possible that the cumulative effect of poor insulation in the circuit parts might account for this, the insulation resistance in any part of the circuit being too high to show appreciable leak. Further testing revealed the high resistance ground to be in the hoist control circuit, and further testing indicated that it was in the bridge circuit and not in the hoist circuit at all, and a check over the previous tests showed that it didn't exist at all, at times, and then roamed around at will from

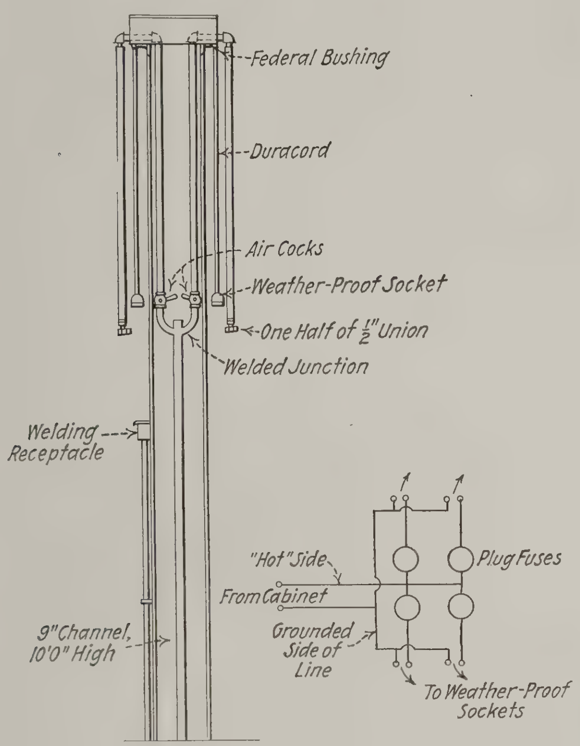


Fig. 2—Sketch of One of the Service Pillars Upon Which Are Mounted Facilities for Obtaining Compressed Air, Lighting and Welding Current

circuit to circuit, and a muddled, chaotic, profanity-provoking state of affairs it was uutil a Shaw plant engineer advanced the opinion that the fun was all due to static. His idea wasn't taken seriously by the shop electricians, but inasmuch as they were "up a tree" it was decided to let him go ahead on his idea. He simply checked over the bonding of the rails and grounding of the runway, swept the rails with a good stiff broom, and advised keeping the rails cleaner than ordinary use effected, and the ground ghost with its attendant sparks and shocks was vanquished. So now another indictment against "static" has been added to that of the radio fans.

Three Euclid jib cranes with 2½-hp. motors are provided to serve the rod gang and lathes, the location is indicated in Fig. 1.

A 50-in. Gray planer has been installed in the old part of the shop with the newly developed Westinghouse Type C variable voltage control. The planer is operated by a 35-hp. adjustable speed direct current motor which is fed from a motor-generator set consisting of a 42-hp. a. c. motor, direct connected to a 250-volt, 25-kw. generator, with a 1.5-kw. exciter, also direct connected. A 6-button push-button master station located on the planer and connected to clapper type contactors placed in the control box provide easy operation and control.

Some interesting mechanical problems have arisen in fitting up some of the old belt driven machines with motors. In the case of the radial drill, the motor has been set on top of the change speed gear box and a gear on the motor meshes with one on the driving shaft of the speed change mechanism. On some of the machines the pulley has been replaced by gear and the motor pinion meshes therewith. Some of the lathes have had a steel angle framework built at the outboard end of the headstock which supports a jackshaft running parallel to the lathe ways and about five feet above the spindle, the motor is on the floor directly underneath this jackshaft which it drives, and the spindle is, of course, driven from the jackshaft.

About 400 horsepower is used in the shop, the largest motor being a 50 hp. on the Sellers wheel lathe and the smallest a 1½ hp. on a sensitive drill press.

Southern Pacific Passenger Cars Being Converted from Gas to Electric Light

The Pacific System of the Southern Pacific Company started in 1923 to convert all gas lighted modern steel passenger equipment to electric lighted cars, the work being carried out at the Sacramento, Los Angeles and Bay Shore shops.

In the main body of each passenger coach eight 50-watt lamps are installed which give sufficient light to enable passengers to read newspapers in any part of the car without eye strain. In cars that are on trains traveling

Type of Battery Boxes Installed by Southern Pacific

over a long distance and where people are to be in the car over night, the eight 50 watt lights in the main body of the car are turned out and night lamps are lighted. These night lamps light the aisle of the car and permit passengers to pass through the car and to see their way about, but are not of sufficient candle power to disturb persons who desire to sleep.

The electric equipment includes a 3-kw. generator, body-suspended, driven by a 5-in. belt. The pulley has a 14-in. face.

Elementary Theory of Alternating Current

A Series of Practical Articles Explaining a Difficult Subject in a Simple Manner

By K. C. Graham

Part VIII.—Synchronous Motors and Converters

THE synchronous motor is much like the alternating current generator in that they both have an armature through which alternating current flows, and a set of field coils that are excited by means of direct current. As in the case of the generator, these machines are almost invariably of the revolving field type. A separate exciter is required with both machines, but there is one feature common to synchronous motors that is not present in the case of the generator—namely, the synchronous motor is usually started up by means of another motor which is either direct connected or belted to it. Of course this condition is, in one sense, paralleled in the case of the generator by the prime mover that is necessary to drive the generator at all times. The windings of the two machines are the same and they may be, as a rule, used interchangeably if occasion so demands. A generator may always be used as a synchronous motor, but it is sometimes impossible to use a given synchronous motor as a generator because of the fact that its field coils are not heavy enough to carry the current necessary to generate a given voltage at a given power factor without overheating the field windings. The mechanical construction of the two is identical.

As in the case of generators, these motors may be wound for either single phase or polyphase current. The field windings are the same for single or polyphase current, but the armature windings are different. They need not be considered in detail at this point because they will be taken up later under the head of induction motor windings.

Synchronous motors operate by virtue of the fact that like poles repel and unlike poles attract. This may be better appreciated by reference to Fig. 66. This figure represents such a motor, the rotor of which is excited by direct current and the stator, by alternating current. The polarity of the rotor and the stator poles is, of course, as in the case of generators, alternately north and south.

It will be noted Fig. 66 (a) and (b) that the stator poles change polarity with each alternation or half cycle. The effect of this phenomenon is that the stator appears to revolve. Thus the pole at 1 is north; a half cycle later the N pole has moved to position 2; a half cycle later to 3, and a half cycle later it is back to 1. In this case two complete cycles were necessary for a complete *apparent* stator, revolution, the machine being of the four pole class. It must be noted that the stator does not revolve mechanically, or actually, but only magnetically as it were.

If the polarity of the rotor poles, and the instantaneous polarity of the stator poles is as shown in Fig. 66 (a), then there will be an attraction between the two sets of poles that are opposite each other. A half cycle later, however, the polarity of the stator winding will have reversed itself, as shown in Fig. 66 (b). It will be noted that the rotor is in exactly the same position as in Fig. 66 (a) and there will be a repulsion between the two sets of opposite poles. It might be wondered why the attraction between unlike poles does not cause the rotor to move around a quarter of a revolution as the stator polarity has done, but it must be noted that the attraction of pole N 2 is just as great, relative to rotor pole A, as is that of stator pole N 4 so that the two of them attract this pole equally and the rotor tends to move in two opposite directions at the same time, the net result being that the rotor

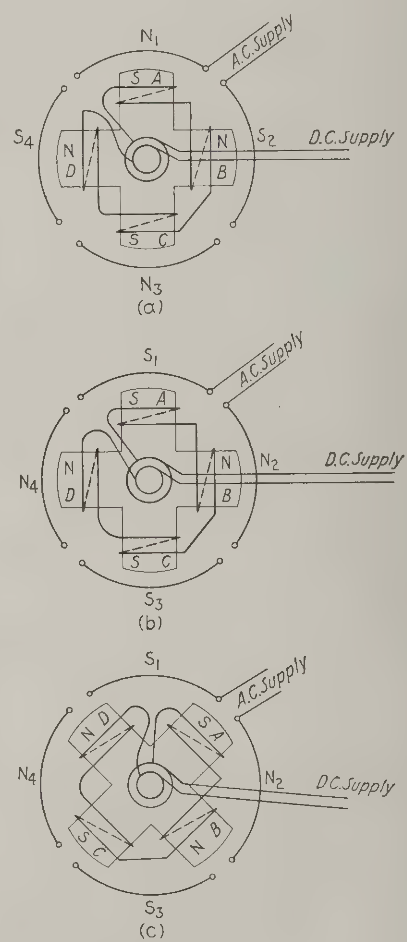


Fig. 66

stands still. Again it might be asked, What would happen if the rotor were resting in such a position that its poles were midway between those of the stator, as in Fig. 66 (c)? In this case pole S 1 would repel A and N 2 would attract it so that there would be a tendency for the rotor to move. If the rotor did move it would certainly not go past that position where its poles are directly opposite those of the stator, because they would be held there due to attraction between unlike poles. As a matter of fact, however, the rotor would move hardly at all because of the fact that the poles of the stator change their polarity

several times per second, this time interval between changes being too small for the inertia of the rotor to be overcome. In the case of a 60-cycle machine the current reverses every 1/120th of a second and it will be readily appreciated that this time is insufficient in which to cause appreciable motion on the part of the rotor because it will be attracted for 1/120th second and repelled the next 1/120th second. This difficulty is overcome by bringing the rotor up to speed mechanically before current is applied to it. Then when the current is applied to the machine the unlike poles attract until the unlike poles are directly opposite one another. At this time the stator

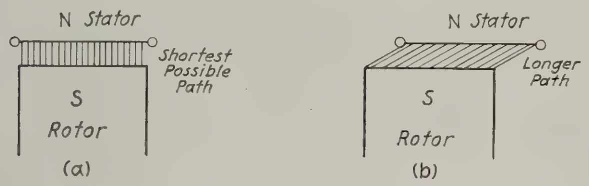


Fig. 67

current is passing through the zero point of the cycle and inertia will cause the rotor to continue moving so that it will be in a "torque" position such as in Fig. 66 (c) before the current has again reached an appreciable value. This action will be repeated throughout each complete revolution so long as the machine is in use, the result being that the rotor will move at the same speed as the stator magnetism. Thus the rotor is said to be in synchronism with the stator and the motor is called a synchronous motor. In the case of a four-pole, 60-cycle machine this speed would be at the rate of 1,800 revolutions per minute. The single-phase synchronous motor cannot be made self-starting, but the polyphase motor may be made so by the addition of special windings on the rotor. As in the case of stator windings we shall look into these special windings in connection with the study of induction motors. At best the starting torque of the synchronous motor is very small, the induction motor being very much superior to it in this respect. It might be asked then, What is the advantage of using the synchronous machine at all? It is used sometimes to maintain a high power factor condition through its own use as a means of power, but it is generally used to correct an otherwise bad power factor condition caused by the use of induction motors on the same line. It may at the same time, of course, supply some power. As we previously learned, the lower the power factor the larger the value of current necessary to supply a given amount of power. The larger the current, the greater the loss in the transmission line. It is apparent, therefore, that it is desirable to keep the power factor of the load as high as practicable. We shall now investigate how this is brought about by the use of the synchronous motor.

When the synchronous motor is operating without load the rotor poles will tend to remain opposite the center of the stator magnetic poles, as shown in Fig. 67 (a). When a load is applied, however, the rotor will tend to slow down so that the distance between any given pole on the rotor will be at a greater distance from the center of the stator pole, Fig. 67 (b), thus increasing the length of the magnetic path and, consequently, decreasing the magnetic flux. This will result in a decrease of the stator counter e.m.f. and more current will flow in the stator winding until a balance is obtained between the decrease of flux due to the lengthening of the path, and the increase in flux due to increased stator current. If the load is then removed, the "pull" on the rotor will be strong enough to bring the relative position of the poles back to the normal, as in Fig. 67 (a). This will increase the stator counter e.m.f. so that the stator current will decrease. Thus the current drawn from the line is automatically regulated to suit the load.

Figs. 68 (a) and (b) will serve to illustrate the effect of this strength of the field current on the action of the synchronous motor. Fig. 68 (a), which is similar to Fig. 67 (a), shows the normal position of the poles. The current in the stator winding is assumed to be at a maximum with the rotor pole in the position shown. After a 45 degree revolution the poles are no longer between the two sets of stator conductors that serve to form a stator pole, but are now cutting across these sets of conductors. At this time the current in the stator winding is passing through the zero point. The direction of the voltage generated in the stator winding by the flux from the rotor poles cutting across the conductors, will be as shown by the arrows in the Fig. 68 (b). The direction of this voltage is seen to be such as to assist the change in direction of the current flowing through the stator winding; in other words the action is similar to that of a condenser placed in the stator circuit. With a normal value of field current this voltage generated by the action of the poles cutting across the stator conductors will be small as compared to the voltage of the generator that is supplying the motor with current, as illustrated in Fig. 68 (c). The effect of this voltage will be such that the self-inductive tendency of the stator winding will be partially, or completely, overcome and the motor will operate at or near

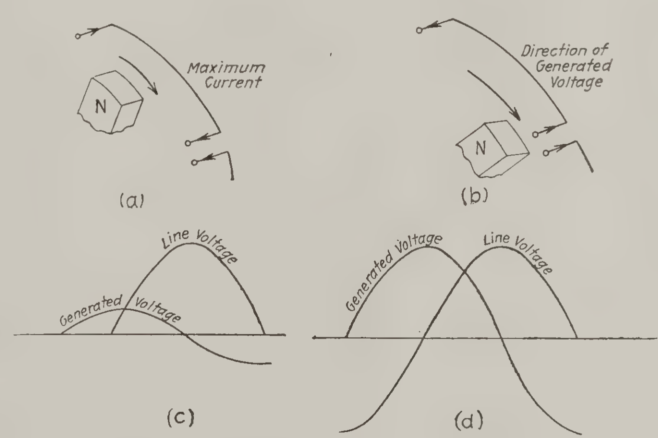


Fig. 68

one hundred per cent power factor. If, however, the field current is increased beyond the one hundred per cent point, the voltage generated in the stator will become larger as compared to the line voltage, Fig. 68 (d), and the motor will draw a leading current from the line. The more the field current is increased the greater will this condenser effect become.

The advantage of using a synchronous motor with over-excited field may be better appreciated by referring to Fig. 69. *G* is an alternating current generator located at a distance of five miles from synchronous motor *M* and five and one-quarter miles from inductive load *L*. If the motor were not operating the "wattless" or reactive current due to the inductance of load *L* would flow all the

way from the generator to the load, a distance of five and a quarter miles. With the motor operating alone, load L being disconnected, the same condition would exist if its field were over-excited but, in this case, the reactive current would be capacitive whereas that occasioned by L was inductive. Now with both M and L connected the field current of M could be adjusted so that its reactance would be just equal to that of L. Therefore M would draw its wattless current from L and vice versa, the result being that the current in the line between the generator and M would be just sufficient to take care of the load based on one hundred per cent power factor condition. In the two cases the output of the generator would need to be equal to the power consumed by the load plus the loss in the line. The power consumed by the load is the same in both cases, but the line loss in the first case will be much greater than that in the second case because of the fact that the wattless current flows over two lines five miles long in the one case, and only a quarter mile long in the second case. We have used the term wattless current, in the above discussion to indicate the excess of current at a low power factor over that required by the load at one hundred per cent power factor; thus if a given load requires 100 amperes at one hundred per cent power factor and 150 amperes at a lower power factor, then the wattless current may be considered as being 50 amperes and the loss in the line in the two cases will be nearly as

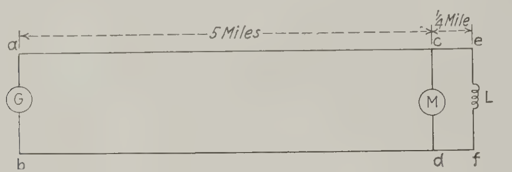


Fig. 69

$(100)^2$ is to $(150)^2$. Referring to the case illustrated by Fig. 69, the wattless loss when the reactance is connected to the line as compared to that when the motor and inductive load are both connected will be in the ratio of [$(150)^2$ times five and a quarter times the resistance per pair of conductors per mile] to [$(100)^2$ times five and a quarter times the resistance per pair of conductors per mile, plus $(50)^2$ times one-quarter times the resistance per pair of conductors per mile]. Since resistance is a constant quantity we may eliminate all reference to it and say that the ratio is [$(150)^2$ times five and one-quarter] to [$(100)^2$ times five and one-quarter, plus $(50)^2$ times one-quarter]. This multiplies out to 95,625 to 53,125 or 1.8 to 1, so that the line loss in the case of one hundred per cent power factor is only fifty-five per cent of that in the case of lower line power factor. Thus, if the line loss were five and a half kilowatts at one hundred per cent power factor, it would be ten kilowatts at the lower power factor, the saving occasioned by the use of the synchronous condenser being readily apparent in this case. When building a new transmission line the designer calculates the effect of using a synchronous condenser at the end of the line and it is often possible to save many times the cost of the machine through the saving occasioned by using smaller wire than it would be possible to use without having a synchronous machine to maintain a high power factor condition in the line.

There are many cases where, for a given cost, it is possible to purchase a machine that will be not only large enough to correct a given power factor condition, but will be large enough to do some other work as well. In such cases they are used on loads that do not require a high value of starting torque; as unloaded air-compressors or apparatus operated through clutch pulleys.

The only difference between the synchronous condenser and the ordinary synchronous motor is the fact that the field coils of the condenser are designed for much larger values of current than are those of the motor. This is, of course, due to the fact that the current in the motor fields needs to be just strong enough to provide normal excita-

Fig. 70

tion while the fields of the condenser must be capable of over-excitation at the will of the operator.

It might be asked, What are the causes of low power factor? The usual causes for this condition are unloaded induction motors or unloaded transformers. Lighting loads or heating loads are practically non-inductive, and the power factor of a *loaded* induction motor or transformer is anywhere between 80 and 95.

There is one peculiarity of the synchronous motor that should be mentioned before passing on to the next subject and that is *hunting*. When a load is applied to the motor the rotor drops back somewhat; if the load is then suddenly removed the rotor will forge ahead and momentum will carry it past the central point. It will then deliver a leading current to the line; this will cause it to slow down until it again passes the central point, this swinging or pendulum-like action being known as hunting. It is prevented by the addition of special windings, called damper windings, to the faces of the rotor poles. These windings are similar to the squirrel-cage induction motor

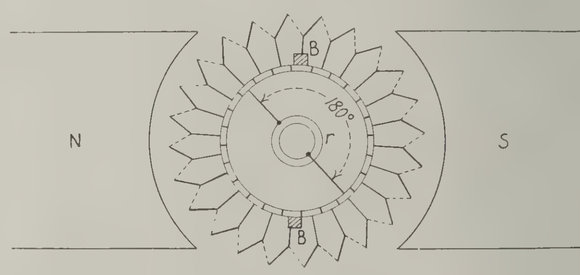


Fig. 71

windings that we shall study in more detail under the heading of induction motors. Their principle is illustrated in Fig. 70.

Pole N, Fig. 70 (a), is surrounded by a closed circuit winding W. If the motor is under load with N lagging somewhat behind the central position, and the load is suddenly removed, N will tend to swing quickly past conductor a. In doing so, however, the winding W will cut across the flux which surrounds conductor a and a voltage will be generated in W. The direction of this voltage is such as to cause a current to flow in the loop, as shown in the figure. The direction of this current is

such that it weakens N and the attraction between N and the stator pole is such that the tendency to swing past the central point is partially overcome. If the pole does swing past this position the loop will come under the influence of the opposite flux, Fig. 70 (b), and a current will flow in the loop in such a direction that the strength of N will be increased and the pole will be attracted to the central position before it proceeds very far in its overswing.

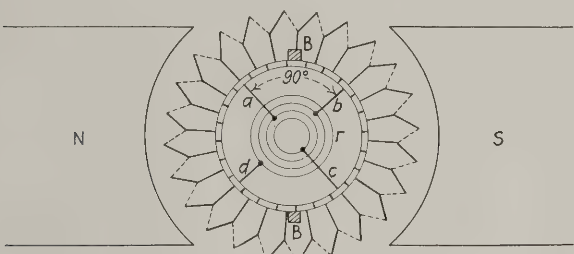


Fig. 72

Thus the action of the poleface winding is seen to be dampening in its effect; hence the name damper winding.

Synchronous Converters

Closely allied to the synchronous motor, insofar as the principle of operation is concerned, is the synchronous or rotary converter. This machine is used for the purpose of changing alternating current to direct, or vice versa.

The principle of operation may be learned with the aid of Fig. 71. The two field magnets are excited by direct current from an exciter or, in the case of direct to alternating conversion, from the line supplying the direct current to the machine. They may also be excited from the commutator of the machine itself in case of alternating to direct conversion if suitable means for starting is provided. The armature is very similar to that of any direct current generator except for the fact that a set of collector rings are attached to the winding. In Fig. 71, which shows a single-phase converter, it will be seen that the winding is tapped at two places, these two taps being connected to collector rings. The alternating current is fed to the armature by means of these rings, thereby

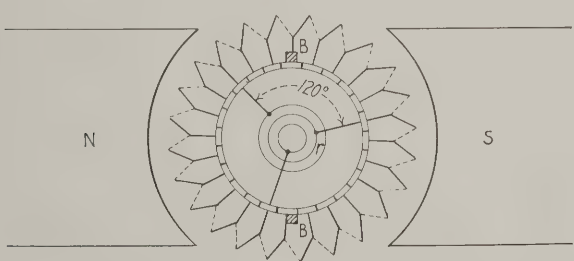


Fig. 73

causing the machine to operate as a synchronous motor. The current flows through the windings to the direct current side of the machine where it is commutated, flowing from the brushes to the load as direct current. It might be supposed that the conductors of the armature would generate a large voltage due to cutting across the flux of the field poles, but such is not the case. The field strength is only varied to maintain the desired power factor of the circuit, the voltage generated in the windings serving to overcome the inductance of the windings as in the case of the synchronous motor. The converter could be operated in the reverse direction, direct current being fed to the commutator and alternating current being collected from the rings. When operated in this manner the convertor is said to be inverted.

Fig. 72 shows a two-phase converter. The difference between this converter and the single-phase one is that the winding is tapped at four places and brought out to four collector rings. A and C are one phase, and B and D, the other. The two sets of taps are seen to be 90 degrees apart.

Fig. 73 shows a three-phase converter, the winding being tapped at three equidistant points. These taps are, of course, 120 degrees apart.

The converter could be driven from some external source and direct current could be collected from one end while alternating current were collected from the other. The machine would then be known as a double current generator, its synchronous feature being conspicuous by its absence.

Although the elementary form of converter that we have considered has only two poles, those met with in

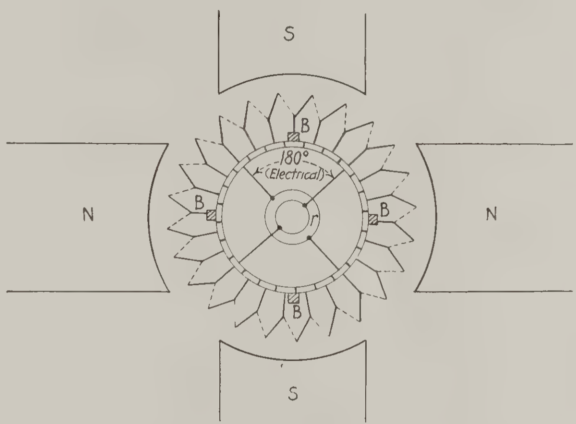


Fig. 74

practice are invariably four, six or more poles. Fig. 74 illustrates a four-pole single-phase converter. It will be noted that taps 360 electrical degrees apart are connected to the same ring. In this instance, a four-pole winding, the taps are 180 mechanical degrees apart. Taps to the second ring are taken off at a distance of 180 mechanical degrees from the first set of taps.

Fig. 75 shows a four-pole two-phase converter. Here the taps are taken off in the same manner as in Fig. 74 with the exception of the fact that another set of similar taps is taken off at a distance 90 electrical degrees away from the first set, this second set of course being connected to two separate collector rings.

Fig. 76 illustrates a four-pole three-phase converter. Here there are three separate sets of taps, 120 electrical degrees apart, brought out to three separate collector rings.

The same method of analysis may be applied to machines of any number of poles. In some cases it is advisable to omit half of the possible number of taps per ring to avoid multiplicity of connections.

Other Types of Converters

Current may also be converted from one class to the other by means of a motor-generator set, which is nothing

more or less than a motor mechanically connected to a generator. Thus an alternating current motor could be belted or otherwise mechanically connected to a direct current generator, alternating current being fed to the motor while direct current were obtained from the generator. Conversely, a direct current motor could be used to drive an alternating current generator. Before taking up the consideration of rectifiers it would be well to mention another type of machine that is used rather infrequently—the frequency changer. In this machine alternating current is fed to a motor that has a certain number of poles. This motor is direct connected to an alternating current generator having a different number of poles, the result being that current at a different frequency from that supplied to the motor is obtained from the generator. Thus a 25-cycle four-pole motor might be used to drive an eight-pole generator with the result that 50-cycle current would be obtained from the generator.

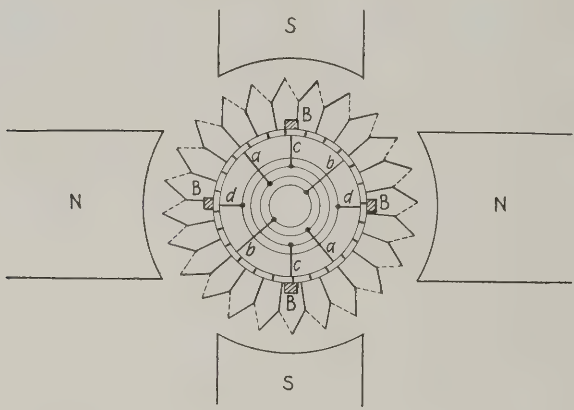


Fig. 75

Rectifiers

There is still another class of converter that is known as a rectifier. There are several types of rectifiers, electrolytic, mechanical, mercury vapor and electro-magnetic.

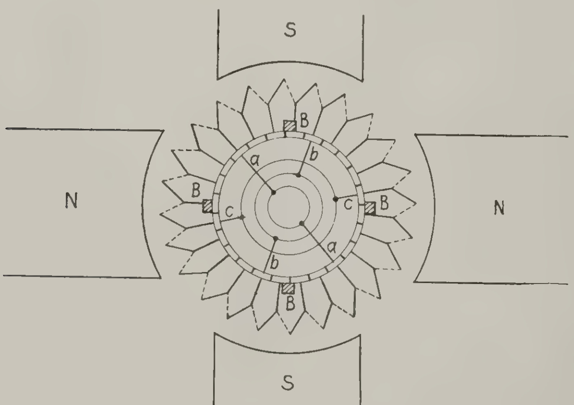


Fig. 76

The most simple of these, as to principle of operation, is the mechanical rectifier. Its principle of operation may be more easily grasped by referring to Fig. 77.

Fig. 77 shows a flat ring made up of four brass or copper segments, 1, 2, 3 and 4 separated by insulating segments *I*. Segments 1 and 3 are connected together as are also segments 2 and 4. Brushes *P* and *N* bear on segments 1 and 4 and serve to carry the direct or rectified current from the machine to the load. The common connection of segments 1 and 3 is connected to a collector ring, and that of segments 2 and 4 is connected to another collector ring. Two brushes, *xx*, which carry the alternating current rest on these rings. This whole assembly is driven by a four-pole synchronous motor.

Current flows from ring *L* to segment 1 to brush *P* to

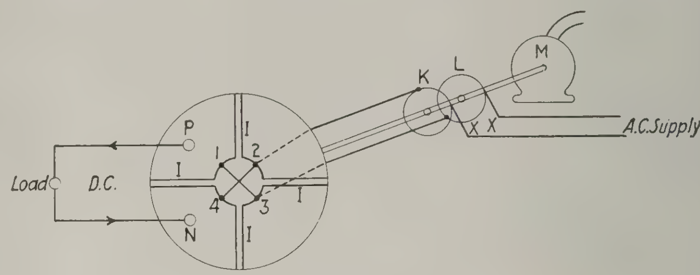


Fig. 77

the load; then through the load to brush *N*, segment 4, ring *K* and out to the line. A half cycle later current flows from ring *K* to segment 4. But segment 4 has now moved a quarter revolution so that it is now in the position formerly occupied by segment 1 and the current flows, as before, from brush *P* through the load to segment 3, brush *N*, collector ring *L* to the line. Thus the current is maintained in the same direction in the direct current circuit.

The electrolytic rectifier is illustrated in Fig. 78. It consists of two aluminum plates *A* and one lead plate *L* immersed in a solution of ammonium phosphate.

It will be noted, Fig. 78, that the two plates *A* are

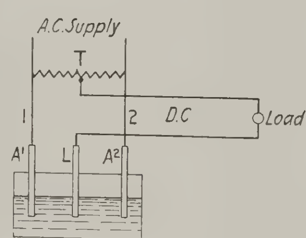


Fig. 78

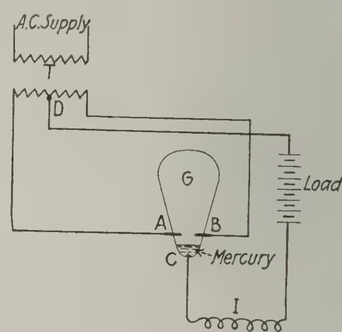


Fig. 79

connected to the line or to the extremities of the secondary of a transformer while the lead plate is connected to one side of the direct current load. The other end of the load is connected to the midpoint of the secondary of the transformer or to the midpoint of a balancing transformer *T*. When the rectifier is operating current flows from wire 1 to *A*1, through the solution to *L*, to the load and from the load to *T* to the other side of the line. As the current flows it causes a film to form on *A* that causes a curious form of resistance to present itself. The film will allow current to flow from *A* to *L* but will not allow current to flow from *L* to *A*. Therefore when the voltage wave reverses, the current will not flow from *T* through the load to *L*, to *A*1 to the line, but it will take the other path from 2 to *A*2 to *L*, to the load to *T*. On the next reversal the current will take the No. 1 path and so on.

Fig. 79 shows the principal features of the mercury

vapor rectifier. *T* is a transformer, the secondary of which is provided with a center tap, *D*. *A*, *B* and *C* are terminals projecting through the glass bulb *G*. *I* is an inductance connected in series between the load and terminal *C*. The lower part of the bulb contains mercury which is a metallic liquid. This liquid is vaporized by means of a separate mechanism and auxiliary terminal which are not shown because their presence is not necessary for purposes of explanation. When the mercury is vaporized it has the property of conducting current in one direction but not in the other, due to a film that forms on the liquid mercury that remains in the bottom of the bulb,

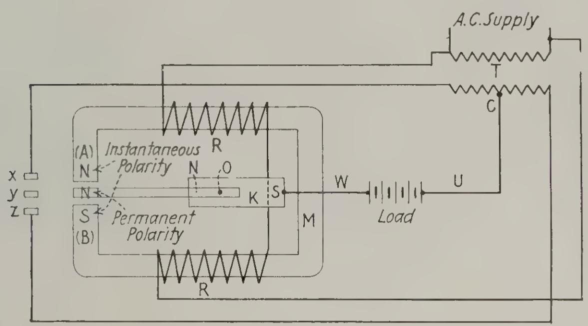


Fig. 80

in contact with terminal *C*. Current flows from *A* to *C* to *I*, through the load to *D* for a half cycle. Then, since current cannot flow from *C* to *A* it will take the path from *B* to *C* to *I*, through the load to D. If the arc formed by the vapor were to go out, or become cold as it were, the path would become non-conducting and would have to be started all over again before the converter would operate. This would be likely to happen, and in fact would happen when the current was passing through the zero point if it were not for the sustaining reactance *I*, which maintains the current through the one path, by means of self-inductance, until current has started to flow in the other. The load in this case is a storage battery.

The electro-magnetic rectifier is illustrated in Fig. 80. It consists of a transformer *T* having a secondary that is tapped at its center *C*; a laminated iron circuit *M* around which arc is wound the sectional coil *R*; a permanent magnet *K* to which is attached steel spring *V*, *V* having a contact point *Y* at one end, and one of the load wires *W* attached to the other end. Adjacent to *Y* are two other contacts, *X* and *Z*, to which are attached the extreme ends of the secondary winding of the transformer. The second load wire is attached to the center tap, *C*, of the transformer secondary. The two halves of coil *R* are connected in series across the line. The flat spring *V* is kept in a state of magnetization by the permanent magnet *K*. Now when the rectifier is connected to the line, current will flow through *R* in a certain direction such that the pole *A* of the laminated circuit is south at a given instant. This pole will then attract *V*, thereby causing *Y* to make contact with *X*. Current will then flow from the transformer to *X*, to *Y*, to *W* through the load to *U* to *C*. A half cycle later the current through *R* will have reversed, *A* will now be a north pole, thereby repelling *V*, while *B* will have become a south pole and will, therefore, attract *V*, causing *Y* to make contact with *Z*. Current then flows from the transformer to *Z*, to *Y* to *W*, through the load to *U* and to *C*, its direction having been maintained constant throughout the cycle.

Induction Motor Winding Connections

By Alfred C. Turtle

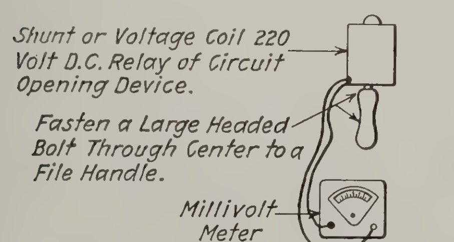
Shop Electrical Engineer, Canadian National Rys.

It is generally the custom in the majority of railway maintenance shops to allocate winding and winding troubles to the armature winder. For instance after the maintenance man or men have established the fact that the motor trouble is not due to exterior overload, or the air gap feelers indicate ample air gap, that bearings are not loose, seized, too hot due to improper oil, water in the oil, choked oil grooves, all phases being supplied with energy at the correct voltage and the like, it is then that the armature winder is expected to correct the trouble.

Why should the armature winder do this if a simple defect which can be remedied on the job, such as cutting out a single coil which happens to be grounded open, or shorted on itself can be safely handled by the maintenance man. Such work can be handled by these men right on the job thus saving hauling, and transfer of sometimes heavy equipment over considerable distances from one shop to another.

A solution of this problem can be often attained by putting the maintenance men through a course of winding. This method under certain conditions is sometimes impractical and therefore a simple instructional system on the various winding methods used is of value.

An outline of such will be shown in the following



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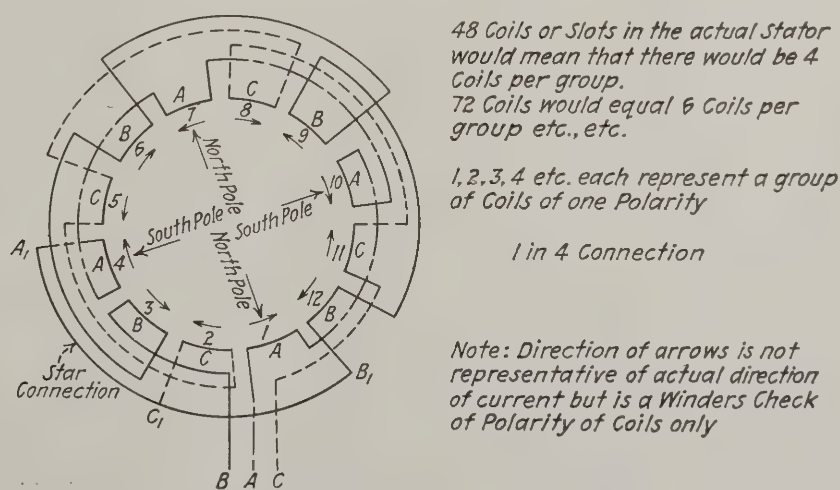


Fig. 1—Three-Phase, 1800 R.P.M., 60 Cycle, Single Circuit, Star Connected Motor Winding Diagram

sketches which can be easily followed by a small amount of reasonable study.

In Fig. 1 is shown the usual method of representing a single circuit star connected three-phase wound stator of an induction motor.

Fig. 2 shows another popular method of representing the same identical winding.

Fig 3 shows the same connection shown exactly as it would appear when looking at the connection side of an actual winding if the said connections were lifted sufficiently to follow each lead. The reader will note that the ends of the coils are shown only.

These figures show what is known as the 1 in 4 connection among winders. On account of neatness and mechanical arrangement most manufacturers use what is known as the 1 in 7 connection which is shown for the same motor in Fig. 4. A study of this shows that instead of connecting every fourth coil or every *A* phase coil in circuit and going once counter-clockwise around the stator, that every seventh coil or north pole coil is connected in going counter-clockwise direction from the lead *A* and that the circuit doubles back and catches each south pole coil on its return to the neutral point or star connection. An examination discloses the fact that this 1 in 7 connection produces exactly the same polarities on the coils as the one in four connection did but it enables the winder to make a neater job than can be made with the 1 in 4 connection but the 1 in 4 connection is generally used on motors from one to ten hp. sizes. From 10 hp. upwards the 1 in 7 connection is most popular.

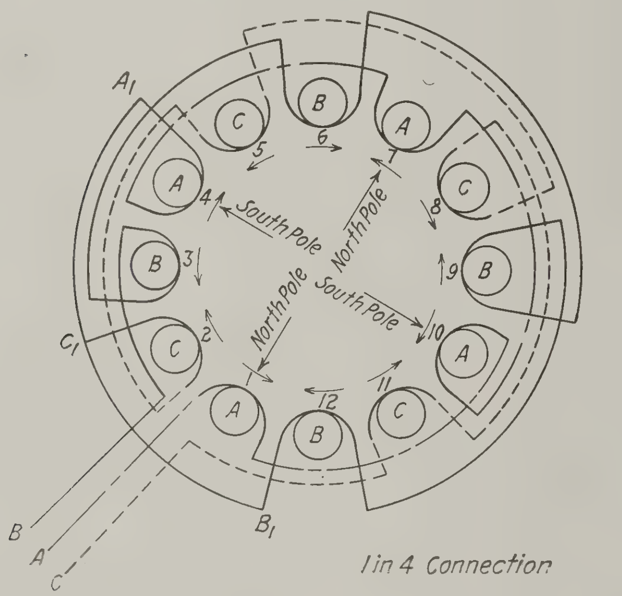


Fig. 2—Same Winding as Shown in Fig. 1, but Illustrated in a Different Manner

On Figs. 1 and 2 the line or circle represents a group of coils numbered 1, 2, 3, 4, 5, etc. On Figs. 3 and 4 the actual end view of each coil in the group is shown. Four coils per group are shown. The motor connection is nominally the same whether three, four, six or more coils are used per group.

The arrows denote direction of current, if *A*, *B* and *C* were connected together to one side of a source of direct current and the star or delta leads, *A1*, *B1*, *C1*, were connected to the other side of circuit. A polarity indicator which can be made up out of a voltage trip coil and with its terminals connected together as shown at left side of Fig. 1 to a milli-voltmeter, by pulling the test coil sharply away from the laminations adjacent each motor coil and watching the meter needle deflection, a sure test can be made of the correct connections of each coil. If the coils are connected correctly the needle will deflect a different direction over each group of coils.

The d. c. circuit in this case will not require a potential of more than 3 or 4 volts.

The above rules are true of nomenclature and diagrams used on two-phase circuits.

Do not, however, confuse such with the actual current values in these motor circuits as the above only represents check and testing out methods of experienced winders.

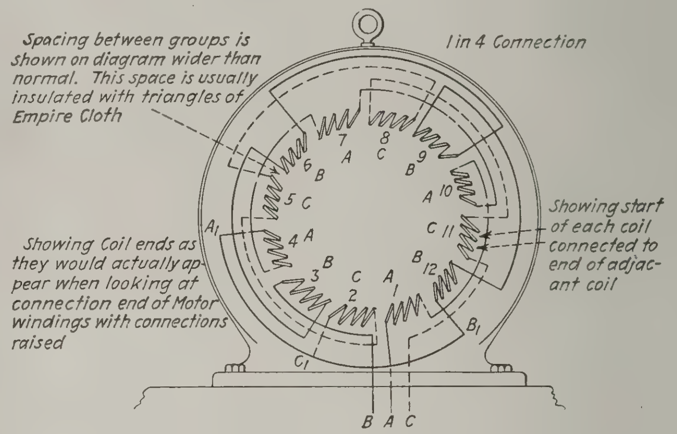


Fig. 3—Showing the Winding as It Would Appear on the Connection Side If the Connections Were Lifted Sufficiently to Follow Each Lead

A study of a three-phase current or voltage curve will quickly point out the actual occurrence of phase values on each set of three groups on a three-phase motor as well as on a two or single-phase motor.

Where a better understanding is desired by the reader of the wide field of winding, books specializing on this subject can be obtained written by a number of competent authorities.

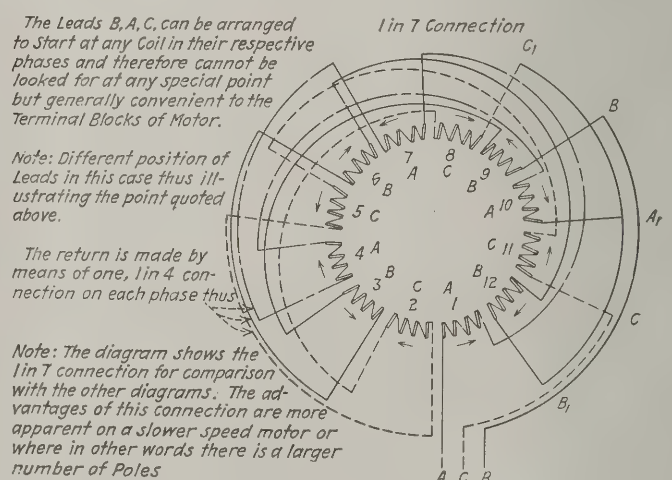


Fig. 4—Winding Diagram Showing the 1 in 7 Connection Used by Many Manufacturers

To obtain the number of poles in a winding divide the total alternations per minute by the revolutions per minute.

To obtain the number of groups multiply the number of poles by 3 in case of threee-phase, 2 for two-phase.

The above applies to diamond coil windings having two coil sides per slot.

Outer Runway of Pere Marquette Enginehouse at Detroit, Mich.

Enginehouse Lighting on the Pere Marquette

All Lights Mounted 12 Feet Above the Floor in R. L. M. Reflectors. Three-way Switches Control Lights

THE modern tendency to make enginehouse lighting comply more closely with the methods and equipment used in other shop buildings is exemplified by the new Pere Marquette enginehouse at Detroit, Mich. The lighting system has been modified to meet the special conditions common to enginehouses, but in general it follows shop lighting practice and provides effective illumination. All of the general lighting is supplied by 75, 100 or 150-watt type C lamps in R. L. M. reflectors, all wiring except feeders is carried in galvanized rigid metal conduit. Feeders are carried on secondary racks outside the building and circuits are so arranged that lighting can be limited only to those parts of the enginehouse where work is being done.

The enginehouse is built in three sections with 10 stalls in the center section and 9 stalls in each of the two end sections. A triangular building adjoining the 5 end stalls of one of the end sections includes a machine shop, locker rooms and office. The corner section of the machine shop adjoining the locker room is occupied by a storeroom separated from the rest of the shop by a wood and wire mesh partition indicated by a dotted line in the drawing showing the plan of the enginehouse.

Power Supply

Power for both the machine shop and enginehouse is brought underground from the power house to one side of the storeroom as 3-phase, 60-cycle, 220-volt power. All of the main switches, control cabinets and meter are mounted on the wall separating the locker room and storeroom. This switching apparatus is shown in Fig. 1. The large cabinet at the left contains the main switch and fuses. A loop is taken from the main switch cabinet and run through the smaller cabinet above in which are mounted the current transformers serving the Sangamo meter mounted on a board at the right of the main switch cabinet.

Beside the main switch and fuses in the large cabinet there are branch blocks from which circuits run to the three 250-volt, 200 amp., Bull Dog switches. One of these is shown at the right of the main switch and the other two at the extreme right of the group. They control the enginehouse lighting circuit, the shop motor circuit and the turntable motor circuit, respectively. From the switch controlling the enginehouse lighting a second circuit is taken through a small Bull Dog switch to the lighting cabinet in the center of the group. This cabinet controls the machine shop lighting circuits. Welding power feeders are run directly from one of the branches in the main switch cabinet. The enginehouse is equipped with an Elwell Parker crane truck, the boom of which is long enough to apply or remove air pumps and front ends. Power for charging the truck batteries is brought from the power house to one end of the enginehouse through a separate conduit, and the truck is run to this point when it is necessary to re-charge the battery. The truck is shown "on charge" in Fig. 2.

Machine Shop Power and Light

The machine shop is equipped with two lathes, two drill presses, a pipe threading machine, a shaper, a bushing press, a grinder, a combination punch and shear, a forge and a motor-driven hammer.

All of the machinery in the shop is driven from a line shaft, which in turn is driven by a 30 hp., 220-volt, 3-phase Howell Motor controlled by an E. C. & M. automatic

starter. The motor and starter are mounted overhead, and the push buttons controlling the motor are mounted at a convenient height on one of the supporting columns.

The hammer is a Nazel hammer also driven by a 3-phase, 220-volt Red Band motor of 10 hp. controlled by an E. C. & M. compensator. The motor and compensator are protected by a 250-volt, 60-amp. Bull Dog line switch.

The machine shop and storeroom are lighted by 75 and 200-watt lamps in Benjamin porcelain enameled R. L. M. type reflectors. The arrangement of the reflectors is shown in the plan of the wiring, Fig. 3. The lamps used in the locker rooms and office are all 75 and 100-watt units except for a 150-watt unit in the office and one 200-watt unit in the locker room section.

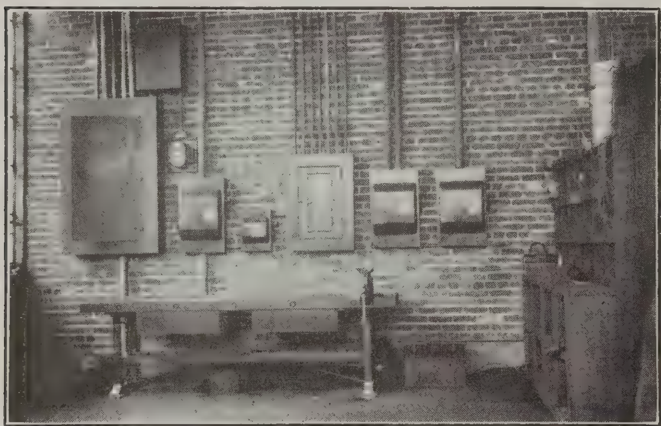


Fig. 1—Switches for Controlling Lighting and Power Circuits in the Enginehouse and Machine Shop

Enginehouse Wiring and Lighting

Six wires for lighting service are carried around the outside of the outer wall of the enginehouse just under the roof on Pierce No. 350 secondary racks. The racks are mounted with No. 3355 extension brackets, and are equipped with No. 355 porcelain insulators. The three lower wires are feeders, the next two are switch legs and the top wire is a ground wire. The feeders are No. 4, T. B. W. P. wire and the other three are No. 6, T. B. W. P. wire. The three-wire 110/220-volt system is used.

Seven No. 6 wires are carried around the inner circle wall in the same manner. Three of these wires serve the welding outlets with power, two of them are switch-legs, feeding the inner circle runway lights, and the remaining two are also switch-legs which feed flood lights mounted on the roof which light the turntable and surrounding tracks.

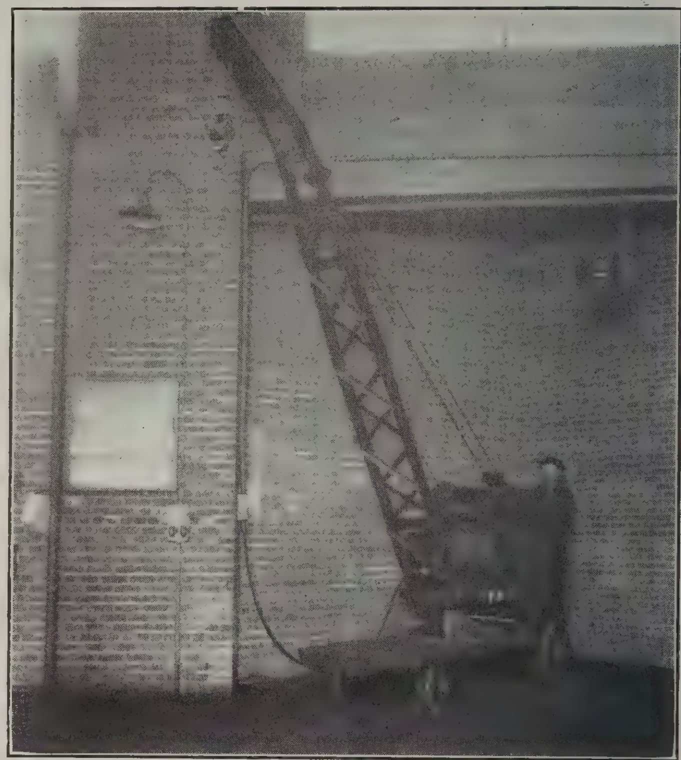


Fig. 2.—Battery-Crane Truck Which Serves the Enginehouse

The switch-leg wires extend all the way around the enginehouse, but strain type insulators are inserted at

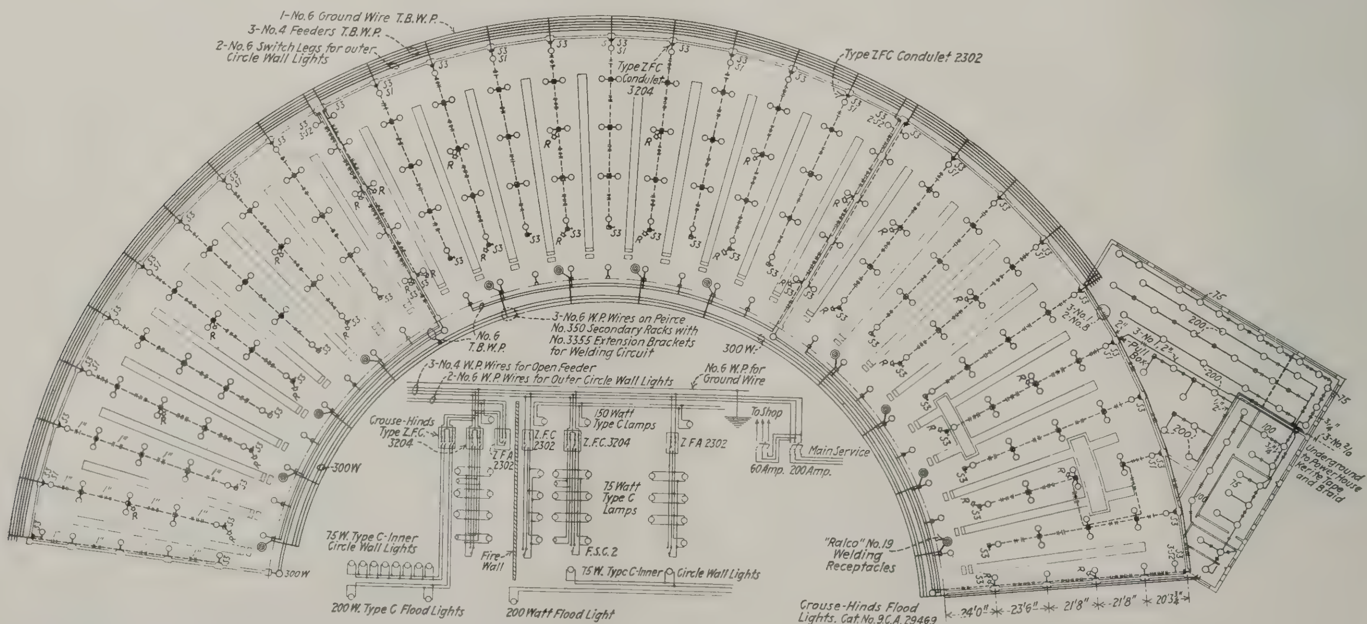


Fig. 3—Floor Plan of Enginehouse and Machine Shop Showing Arrangement of Wiring and Outlets. Typical Wiring Diagrams of Stalls Are Shown Inside the Circle

intervals as each switch-leg supplies four 150-watt lamps or eight 75-watt lamps.

At points midway between stalls on the outer circle wall the feeders are tapped and three wires are brought in through a type F condulet and ¾ in. conduit to a type Z F C condulet. At two places in each section there are two of these condulets as shown in Fig. 4. At one location in each section there are three condulets.

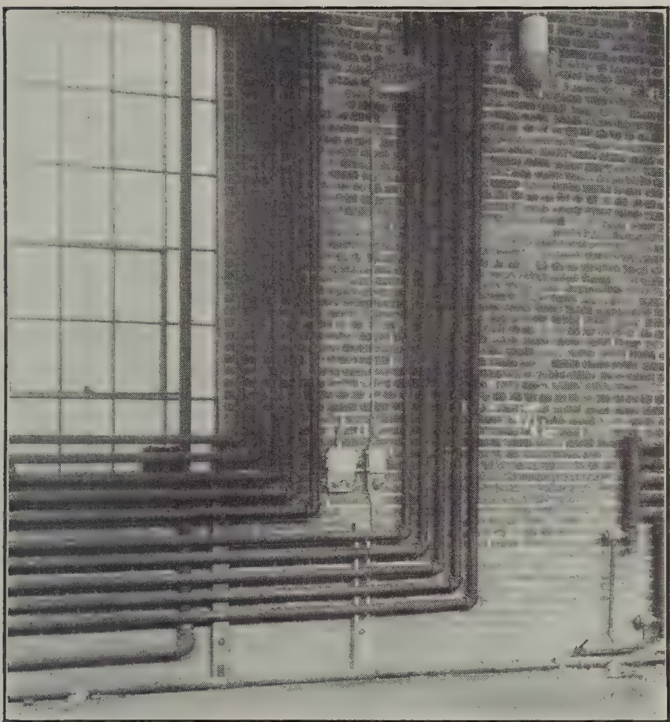


Fig. 4—Typical Location of Switches and Runway Light on Outer Circle Wall

At locations where there is one condulet, with one switch, the switch is a three-pole switch controlling the lights between stalls. There are seven 75-watt lighting units in Benjamin R. L. M. type reflectors between stalls mounted on goose necks from the roof supporting columns 12 feet above the floor as shown in Figs. 3, 5 and 6. The enginehouse is provided with an inner as well as an outer runway, and on each of the columns just outside the inner runway there is another three-pole switch which also controls the lights between stalls.

Where there is a switch location on the outer circle wall having one condulet with two switches, one switch is a three-way switch which controls the overhead lights between stalls, and the other, which is a single pole switch, controls an extension circuit. Extension outlets are provided on every other row of columns. These outlets are Ralco No. 15 receptacles, and they are mounted and located as shown in Figs. 3, 6 and 7.

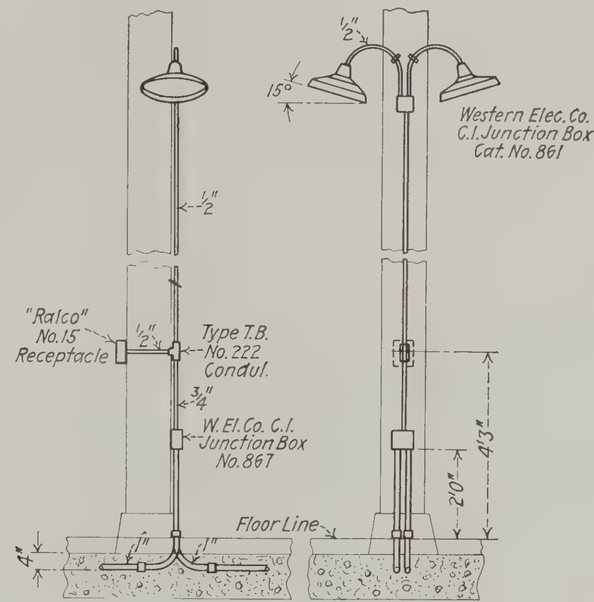


Fig. 5—Details of Lighting Fixtures Mounted on Supporting Columns

Where there are two Z F C condulets at a location on the outer circle wall, as shown in Fig. 4, the switches in one control extension circuits and between stall lights and a tap is taken from the first to the second condulet in which there is one double-pole switch, which controls four of the 150-watt lights in the outer circle runway. These lights are also mounted in R. L. M. reflectors located as shown in Figs. 3, 4 and 6.

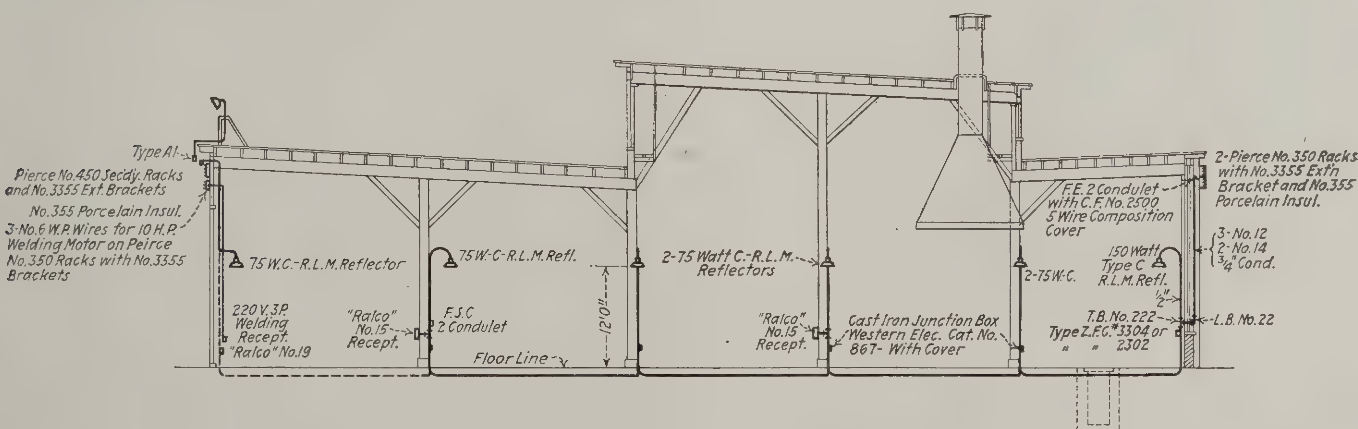


Fig. 6—Cross Section of Enginehouse Showing Location of Lighting Units, Extension Outlets, Switches, Welding Outlets and Feeders

At one location in each section there is a third condulet with two switches, one of which controls the eight 75-watt lights over the inner runway in that section. Three of these lights are shown in Fig. 9. The other switch controls the two 200-watt flood lighting units mounted on the roof of that section. The total of six flood lights

provide light for the turntable and surrounding tracks.

The outside of the outer enginehouse wall at one of the switch locations is shown in Fig. 8. Taps from the three feeders are carried down through the left-hand conduit to the condulets and switches and secondary leads are brought up from the switch through the right-hand conduit to the switch-leg, which in turn feeds the outer circle runway lights.

All of the conduit used is hot dip galvanized conduit and all of the conduit inside of the enginehouse except for risers is run underneath the floor. All conduit run under the floor is 1-in. conduit and joints in this conduit are made up water-tight with white lead. The risers to the lighting units are made of ½-in. conduit and Western Electric No. 867 cast iron junction boxes are used at the junctions between the 1-in. and ½-in. conduit.

The welding set used in the enginehouse is a portable

Fig. 7—A Portable Extension Outlet Mounted on a Post or Supporting Column

set on a four-wheel truck consisting of a three-phase induction motor direct-connected to a welding generator. The welding feeders as described previously are run on brackets on the inner circle wall just under the roof.

Four 10-in. sections of 3-in. pipe welded vertically to a plate mounted on the truck ars used as holders for different kinds of welding electrodes.

Welding power outlets which furnish power for the motor of the welding set are mounted on every other one of the inner circle columns. These outlets which are Ralco No. 19, 220-volt, 3-pole receptacles are mounted as shown in Fig. 9 and located and connected as shown in Figs. 3 and 6.

The Engine House was designed by the engineering department of the Pere Marquette Railway Company and built by Battey & Kipp, Inc., engineers and constructors, Chicago. Mr. J. Tuthill, assistant chief engineer of the Pere Marquette Railway was director in charge of this work and the electrical installation was under the super-

Fig. 8—Outside of Outer Circle Wall Showing Open Feeders and Conduit Which Carries Branches and Switch Loops

vision of Mr. F. E. Starkweather, electrical engineer of the Pere Marquette Railway Company.

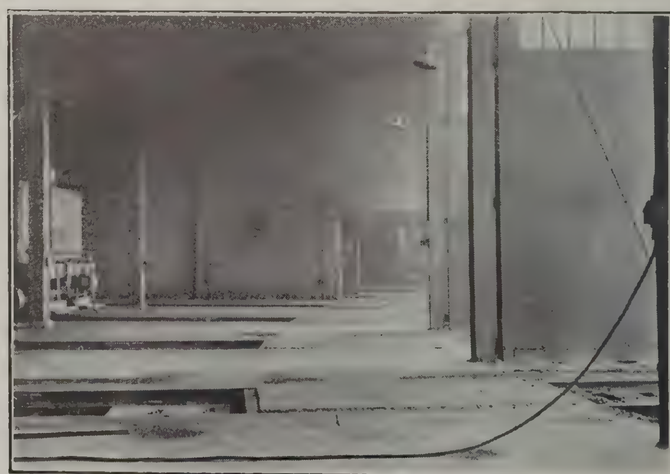
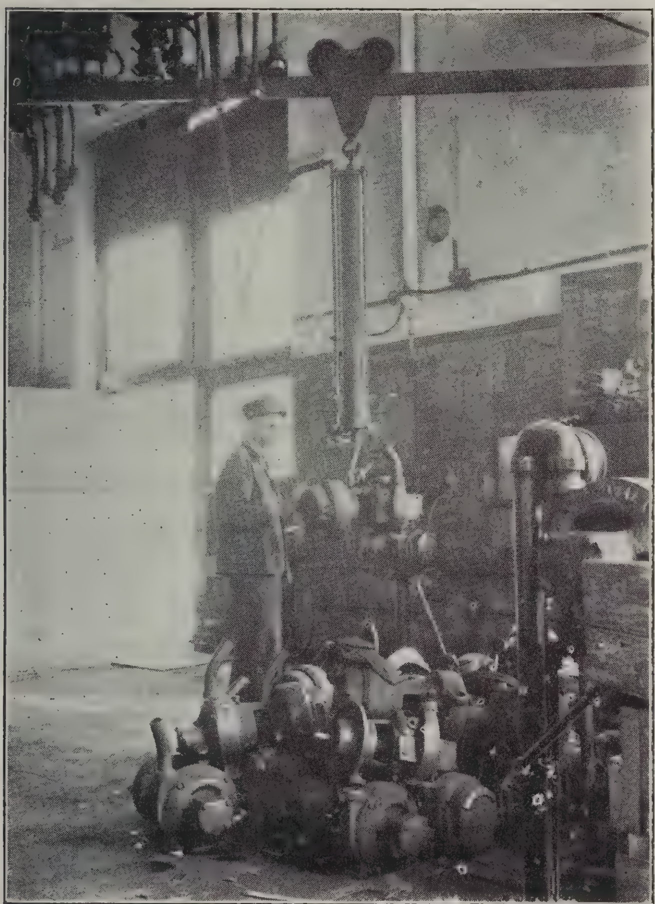


Fig. 9—The Inner Circle Runway Showing Runway Lights and Welding Outlet at Extreme Right

Headlight Maintenance on the Michigan Central

Experience of This Road Indicates That It Is Cheaper to Buy New Parts Than to Rebuild the Old

REGARDING the matter of headlight maintenance, which has been giving the roads much concern during the past few years, opinions are bound to differ. Some roads rebuild extensively worn parts of turbo-generators, but the Michigan Central has found in its particular case, at least, that it does not pay to rebuild many of the worn out parts of this equipment. After a careful study of all of the factors entering into the repairs of headlight apparatus, this road has arrived at the conclusion that it is more economical to buy new parts than to attempt to rebuild the old.



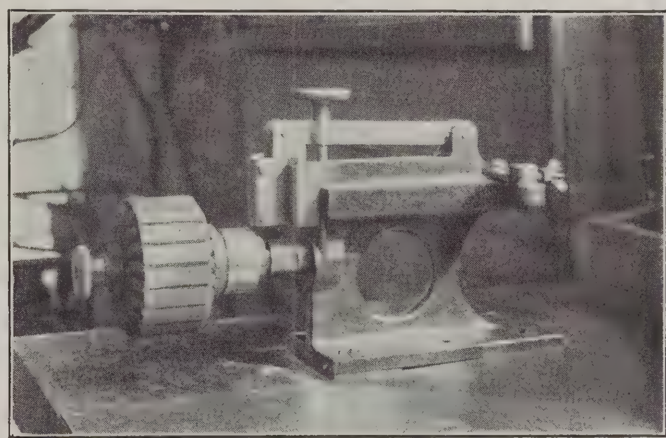
Pneumatically Operated Swinging Crane Used in Transferring Headlight Machine From Floor to Work Bench and Testing Bench

Probably the most extensive repairs which the Michigan Central makes to its headlight equipment is that required by the field coils. The field coils are not re-wound, however, as is done on many roads, but by certain methods the old coils are put into first class condition, and when so repaired have a remarkably long life when returned to the locomotive.

The two points where headlight equipment is overhauled are at Jackson, Mich., and St. Thomas, Canada. There are five divisions on the road, one being in Canada and four in the States. Once every 30 days all headlight material that has been removed from locomotives in Canada is shipped to St. Thomas shops, where it is reclaimed in exactly the same manner as it is in the Jackson shops which repair all of the apparatus coming from the four divisions in the States.

These repairs not only include the turbo-generator parts, but cab fixtures, conduits, sockets and other parts. Field coils that are removed from outside points are sent into Jackson to be repaired.

The time that the headlight equipment is given a general overhauling corresponds to the time when it is necessary for the locomotive to go into the back shop for repairs. The turbo-generators are brought in from the back shop, and the first operation performed upon them is that of cleaning. The head is removed, the armature taken out and the remainder of the machine is then taken outside and blown off with steam to remove all dirt as collected. The machine is then put upon a testing bench where the turbo-wheel is taken off and given a careful examination. At this time all worn parts such as bearings, valve parts, etc., are replaced with new parts. The shaft is straightened and the wheel balanced. It is usually found that quite a large number of the machines require new valves put in them. The wheel is then put back into the machine, and this part of the turbo-generator is ready for the test bench.



Commutator Under Cutting Machine Designed and Built in the Shop. Cutting Edge Is Moved Forward by Horizontal Hand Lever Which Is Not Completely Visible in the Picture

The armature, which has been previously removed, has the commutator turned down and the mica undercut by a special machine designed and built in the shop. The work of undercutting the mica is very easily and quickly done on this machine, the depth of the undercutting being determined by the adjustable hand wheel with threaded spindle which permits the cutter to be raised or lowered at will. The cutter used in this particular outfit consists of nothing more or less than a piece of broken hack saw blade. This, however, answers the purpose admirably. The blade is fixed in a vertical position, and only the extreme lower end is used as a cutter.

New brushes are next put in the brush holders, and these are sanded to fit the commutator. The electrical

end of the machine is then put together, a pair of repaired field coils being generally used, and the apparatus is ready for test.

It should be noted here that all turbo-generators as they go through the shop if equipped with soft packing have this packing removed and metallic packing substituted. Also, the so-called safety feature which is built into these machines for the purpose of regulating the speed in the event the governor becomes stuck, is removed, as the Michigan Central has found that this safety feature is not necessary.

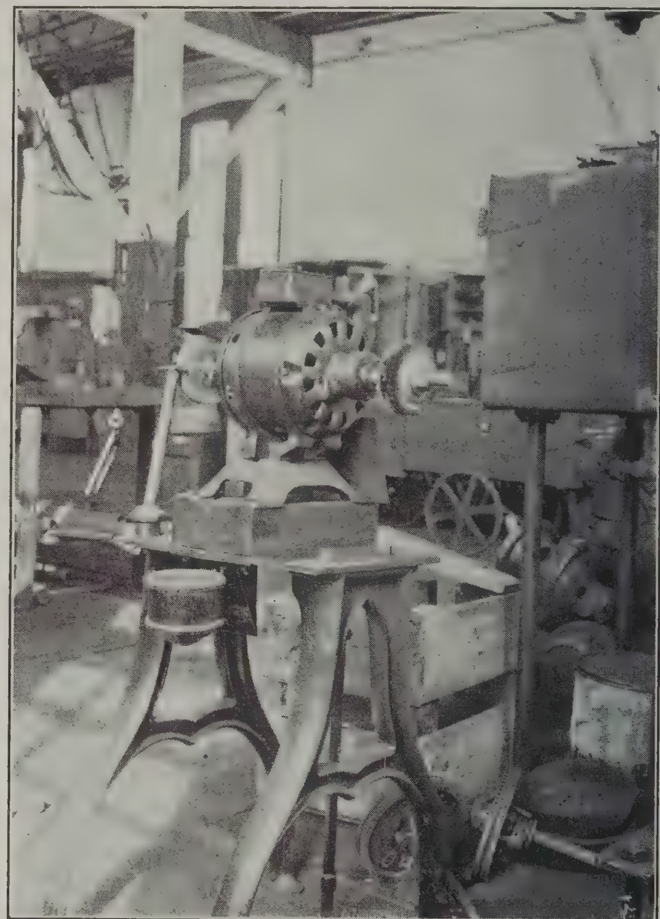
When the machine is put on the test bench for trial, the steam is turned on and the generator operated as far as possible under the same conditions as prevail on the locomotive. The voltage rating must be not less than 32 and the governor is so adjusted that the speed will not exceed 4,000 r. p. m. Care is taken to see that the binding post on the right hand side of the machine facing the commutator is the positive terminal of the machine.

When the test run has been completed the machine is stamped with a serial number, painted, the engine number put on and it is ready for the locomotive.

The instrument board used in connection with the test bench carries a volt meter, an ammeter and a steam gage. To a certain extent the board is wired in duplicate; that is, there are two headlight dimmer switches to correspond with two test benches so that it is possible to actually test two machines at the same time. Behind the board is located a bank of lamps which constitute a load that is the equivalent of the load carried on the locomotive.

Balancing Machine for Testing Turbo Wheels. Provision Is Also Made for Arranging Shaft in Vertical Position

The greatest single factor in the maintenance of field coils, and the one which gives the most trouble, is the carbonizing of the coils. This condition is largely brought about by the leakage of oil which gets through, and consequently the main consideration in renewing these coils is to devise some means whereby the oil can be kept out of the coil windings. The method of handling the coils is as follows: All of the old tape is removed, and if the coils are very greasy they are washed in naptha. After that has been done they are dipped in compound and baked in a steam oven. When the baking process has been completed the coils are carefully wound with varnish cambric tape about $1\frac{1}{4}$ in. wide. This tape is put around both the series and shunt coils so that when finished it has the appearance of a single coil. At the point where the heavy leads from the series coil protrude small holes are put in the cambric tape in order that these leads may extend through. Further protection is then afforded to winding by slipping a piece of cotton sleeving over each of the leads of the series coil. For each lead a short piece of sleeving is cut and flared out at one end so that when slipped over the coil lead the sleeving tends to spread out at the bottom against the varnished cambric tape. This flared out end of the sleeving is then fastened securely against the inner surface of the coil by wrapping closely around it a number of turns of linen tape. When this taping process has been completed the coil is once more dipped in compound and baked.



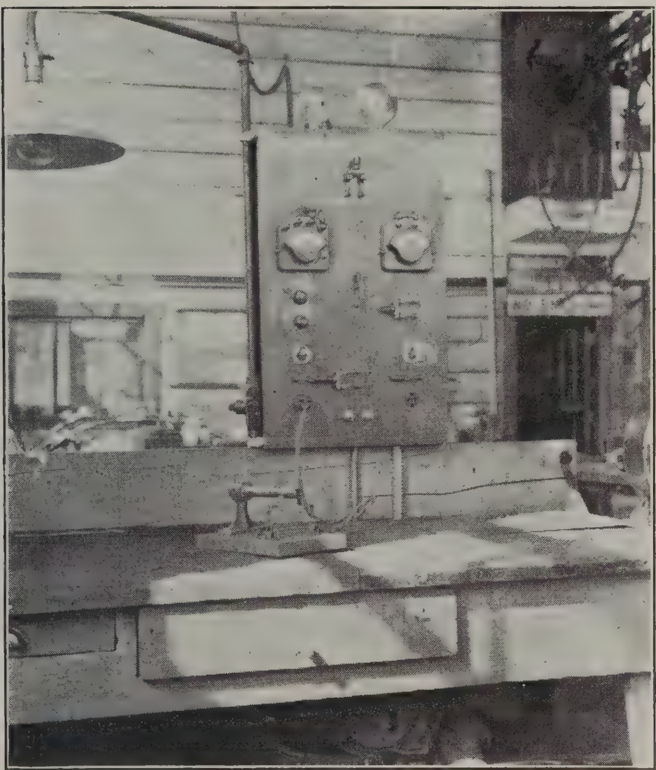
Combination Grinding and Buffing Machine. One Side of the Baking Oven Is Shown at the Right

All of this procedure is done for the express purpose of keeping oil out of the windings, and the experience of the Michigan Central has been that it is highly successful. Coils which have been repaired in this manner show not the slightest trace of oil in the windings after having been in service for periods as long as $1\frac{1}{2}$ years.

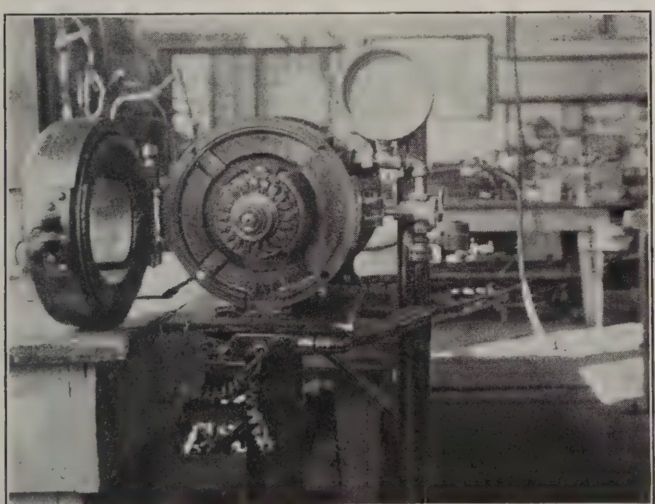
Armatures are tested by the aid of a simple supporting stand consisting of a piece of shaft held rigid over a horizontal board, the front part of which carries two brass springs that press against the commutator. Cur-

rent is led to these springs and thence to the commutator and windings, and by making the bar to bar test with volt meter leads the condition of the windings may be accurately determined. For this test 32 volts are used.

At the bench where this electrical testing work is done, a small switchboard has been set up which makes it possible to quickly establish such circuits as are required in making the necessary tests. At this point also there is located a turbo-generator frame arranged with a swinging front so that field coils or armatures can be readily inserted into it for the purpose of test. In this case, however, the turbine is driven by air pressure at 90 lb. This arrangement keeps the frame cool at all times, and the coils and armatures can be readily handled. The output of this set is conserved, as is also that of the turbine test bench previously described. Both of these sources of currents feed into a line running to another part of the shop where headlight and marker lamps are tested. The circuits are so arranged through switches on the small switchboard that the output of the air-driven set may be sent into this line or not, depending upon circumstances. A 110-volt alternating current circuit is also brought to this switchboard, and this is used in making certain tests which require larger currents, the amperage in such cases being determined by lamps of various sizes.



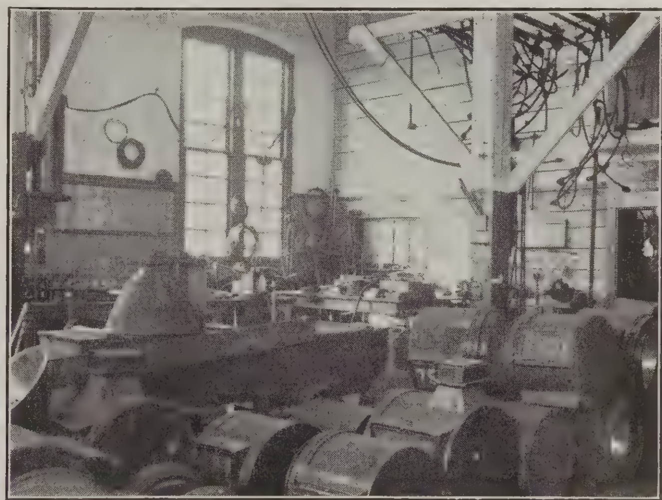
Bench and Switchboard Where Electrical Tests Are Made on Field Coils and Armatures



Generator Frame for Testing Field Coils and Armatures—Swinging Front Feature Built in Shop. This Machine Is Driven by Air Pressure

In order to expedite such repairs as require it an oxy-acetylene welding torch has been arranged by means of suspending long rubber tubes carrying the gases on a taut wire over a part of the shop. This tubing is supported at intervals by pulleys which ride along the wire, and the welding torch can be used anywhere within the length of the tubing, while at the same time the working space is not encumbered with apparatus.

Another point of interest in connection with this headlight reclamation work is the method used by the Michigan Central in handling conduit. Whenever locomotives come into the back shop for general overhauling all of the conduit is removed from the locomotive, both interior and exterior. As far as possible, this conduit is taken down intact, the wires remaining in the conduit. These various parts are then tagged with the number of locomotive from which they were taken, so that they may be quickly installed again as soon as the work has progressed to the point where this can be done. In like manner all of the drop cords to fixtures are kept in a separate group by themselves, so that when this material is again assembled it will be returned to the same locomotive from which it was removed. To facilitate the matter of quickly selecting the proper group of the fixture cords a rack has been provided with hooks, each hook carrying those cords which belong on a certain locomotive.



General View of Repair Shop. Conduits Shown in Upper Right Hand Corner Are Waiting to Be Returned to the Locomotives They Were Taken From. The Tubing Used in Gas Welding May Be Seen Suspending From a Horizontal Wire in Background

In conclusion it may be said that the Michigan Central does not go in for the manufacture of headlight parts, but instead they devote their attention entirely to maintenance. They believe that they can buy parts cheaper than they can make them, and by so doing give their organization more time to devote to maintenance and operation. This conclusion was not arrived at by mere guesswork, but by keeping careful cost record of headlight maintenance work over an extended period of time,

Thawing Pipe Lines With Electricity

Electricity is the ideal medium for thawing out frozen water lines under practically any condition. Lead and iron pipes are both relatively poor conductors of electricity and, therefore, if a heavy electric current is passed through either lead or iron piping, the resistance offered by these metals to the flow of the current will change the electric energy into heat. This heat is generated nearly uniformly along the entire length of pipe through which the current flows. The possibility of so heating a long section of pipe uniformly makes the electrical method of thawing frozen pipes highly effective.

For thawing out ordinary service pipes, it has been found that a current of 150 to 300 amp., at 55 to 110 volts, applied for 5 to 15 min., will usually be sufficient. The time, of course, depends upon the length of the frozen section and upon the degree to which the pipes are frozen. No general information can be given as to the time it will take to thaw out different lengths of pipe, as values will vary greatly, depending upon the size and length of pipe, its location above or under ground, the condition of soil, etc.

The following table gives some results which have been obtained by the electrical method:

Size of Pipe Iron, In.	Length Feet	Amperes	Volts	Time
¾	100	135	55	10 min.
1	700	175	55	5 hr.
2	50	500	55	2 hr.
4	800	300	55	3 hr.
6	400	800	110	2¼ hr.

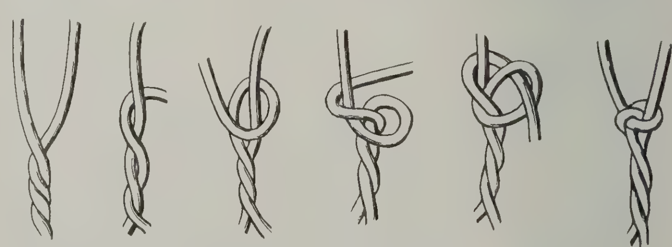
For railway work, a very simple set could be constructed for operating off a 2300-volt alternating current circuit, consisting of two 10 or 15 kv-a, 2300-volt distribution transformers connected to give 55 or 110 volts secondary at no load. In the first case, the primaries are connected in series and the secondaries in parallel, while in the second case, both primaries and secondaries are in parallel. Beside the two standard distribution transformers, all that is needed is two cutouts and fuses for the primary and one primary ammeter. No regulating apparatus is necessary, as variation in current may be had by changing the connection and by looping the secondary cable. This set could be mounted easily on a flat car and moved from place to place, as desired.

If 2300-volt alternating current lines are not available, 440, 550 or 600-volt alternating current transformers can be used in place of the 2300-volt ones.

One of the most notable instances of pipe thawing is that carried out on a 6 in. line about 1700 ft. long extending from 140th street, New York to North Brothers Island. This line was laid in salt water at a maximum depth of 80 ft. below the surface. It was frozen in February, 1912. Temperatures taken of the water showed a surface temperature of 32 deg. and 29 deg. at a depth of 50 ft. Also temperatures taken later showed 29 deg. at 15 ft. below the surface. The line was thawed out by installing four 100 kw. transformers, stepping the high tension current down from 2,000 volts to 200 volts. The current used ranged from 800 amperes at 200 volts to 1800 amperes at 368 volts. The time required to thaw out this pipe was a little more than five days.

How Drop Cords Should Be Knotted

Although lights suspended from drop cords are not as common as they once were, there are still many installations of this kind and the information given here may prove of value to some who have to maintain or install wiring of this character. In a recent issue of the Industrial Engineer, a writer pointed out the importance of using the proper method of making a knot in the cord for supporting lamps. As with many other things, there are too many ways of doing them which are incorrect, whereas, in this particular case at least, there is but one way that



Showing the Various Steps in Making an Underwriters' Knot

will satisfy the underwriters' inspector and that is by using the so-called underwriters' knot.

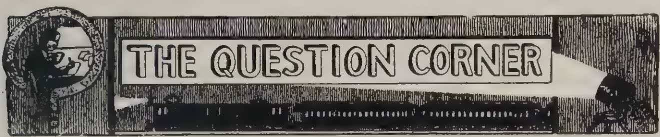
It is fairly obvious that unless the knot is properly made, it is liable to pull through the hole through which the cord passes and put the entire strain of the weight of the lamp and shade on the binding posts of the outlet. This is the result of making the knot in the wrong way. On the other hand, if the knot is made corectly, the weight of the lamp and shade will not cause any strain to come upon the binding posts and will last indefinitely without the least danger of loosening the connections.

The method of making the underwriters' knot is simple

enough and the knot can be made quite skillfully by any one after a little practice. Unfortunately, however, unless one has occasion to make this knot often, one is liable to forget the exact manner of twisting the ends about to accomplish the result. The succeeding steps of the underwriters' knot are shown in the order of their making and it might be a good idea for some who are not quite sure about how it is done, to spend a little time in the practice of tying this very useful knot.

Copper Tubing for Oiling Mechanisms

A piece of 1/8-in. enameled copper tubing is a great help in getting oil to otherwise inaccessible oil holes. In practice a piece about 1 foot long is used. The annealed tubing may be bent to any desirable or necessary shape. One end is placed in the oil hole and the oil is dropped into the other end of the tube by means of any hand oiler. The oil flows down the tube to the oil hole thus eliminating waste of oil. Ordinary copper tubing may be handled by first heating it and then plunging it into cold water. The tubing may then be bent to any desired shape to reach the oil hole.



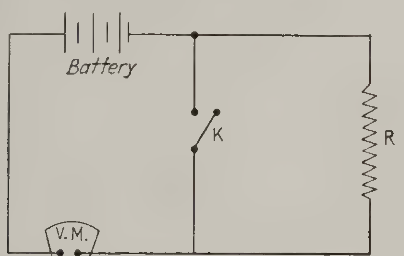
Answers to Questions

1. Is it possible to measure resistance with a voltmeter and if so, how can this be done?

2. I would like to have you explain the operation of a Wheatstone bridge. How is this apparatus used in finding faults in underground telephone cables?

Measuring Resistance With Voltmeter

1. It is quite possible to measure resistance with a voltmeter although this method is of greatest use for the



Connections for Measuring High Resistance with Voltmeters

measurement of very high resistances. All that is required is a voltmeter of known resistance. The connections are made as shown in the following diagram. The value of the unknown resistance is found by substituting the voltmeter readings in the following formula:

$$R = r\left(\frac{d}{d_1}\right) - 1$$

Where R = the value of the unknown resistance r = resistance of the voltmeter, d = voltmeter reading with switch K closed, and d_1 = voltmeter reading with switch K open. This method is especially adapted for the measurement of insulation of wires or similar high resistance.

The Wheatstone Bridge

2. There are many forms of the Wheatstone Bridge, some of which are very elaborate, but for illustration the diagram given here will show the principle of its operation. It will be seen from the sketch that there are four sides to the bridge, three of which consist of known resistances which are adjustable. These are designated as the bridge arms and are indicated as *A*, *B*, *C* and *D*. Between *A* and *C*, and between *B* and *D*, a sensitive galvanometer *G*, is connected through a key. When the bridge is used for measuring an unknown resistance such as *D*, the arms *A* and *B* are set at some fixed ratio. For example: The arm *A* may be adjusted to 10 ohms, while arm *B* may be

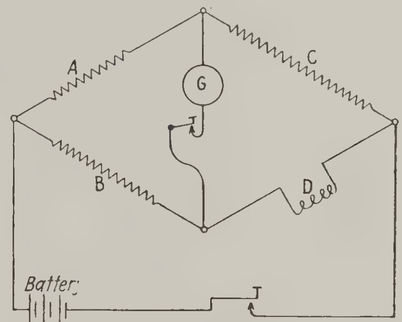


Diagram of Wheatstone Bridge

adjusted to 100 ohms. The unknown resistance is connected as shown on *D*. The arm *C* can be adjusted very much closer than the other arms. By closing the two keys, current will flow to the junction of *A* and *B*, where it will divide inversely in proportion to the resistances of the two arms. The first time the key is pressed, it is more than likely that the needle of the galvanometer will swing violently, but by making successive adjustments on the arm *C* eventually a point will be reached at which the galvanometer needle will remain at rest, when the galvanometer and battery keys are closed. The bridge is then said to be balanced and under this condition the resistance of the various arms bear a fixed relation to each other shown in the proportion $\frac{A}{B} = \frac{C}{D}$. Since *D* is the value sought and since all of the other values are known the formula can be written

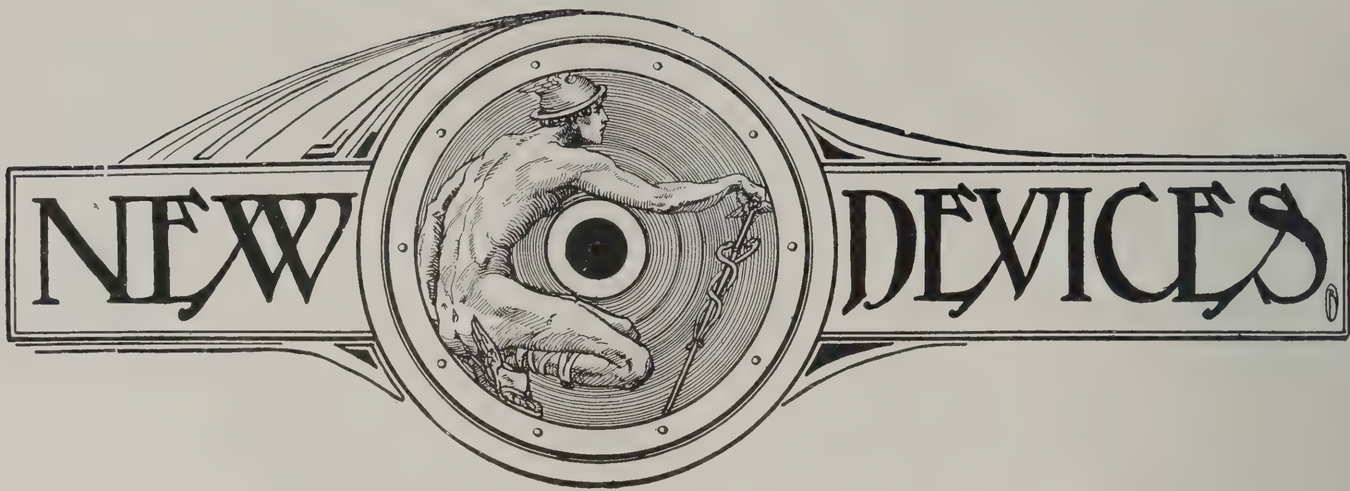
$$D = \frac{C \times B}{A}$$

from which it is an easy matter to determine the value of *D*.

The locating of faults in underground telephone cables, involves the use of Wheatstone Bridge. It is used, however, in a somewhat different manner from that just shown and the process, while not complicated, is a little too long to be given here this month. In a later issue this method will be given completely, with diagrams and formulae from which any ground or cross in underground or aerial telephone cable may be very closely located.

Questions for January

How is a Wheatstone Bridge used in locating faults in underground or aerial telephone cables?



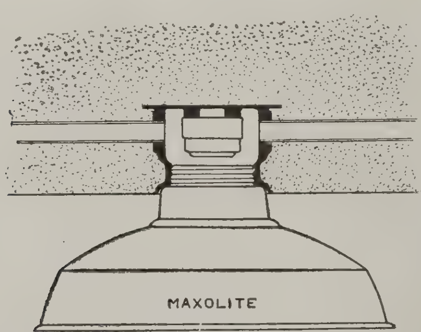
Moisture Proof Outlet Box

The Central Electric Company, Chicago, Illinois, has recently designed a new type Maxolite outlet box with threaded holder for use in shops, round houses, docks, platforms, subways, and all places where there is a considerable amount of moisture of condensation. In such localities the use of a regular pressed steel outlet box

The Moisture-Proof Outlet Box with an R L M Reflector Attached

is undesirable owing to the rapidity with which it is destroyed by rust and corrosion.

The railways have found it desirable to use cast iron fittings in such locations, and this combination hood and outlet box is designed to fulfill this need. The deep skirt



The Outlet Box as It Is Used in Concrete Buildings

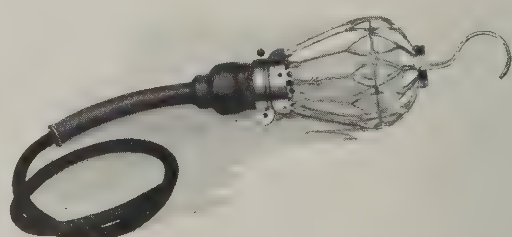
of the box completely covers and protects the junction between the reflector and the threaded portion of the box preventing accumulation of moisture in this junction.

There is a heavy box flange at the bottom drilled with four holes for supporting the box. On the outside there are four holes large enough to be drilled and tapped for either ¾ or ½-inch conduit. The socket is a standard No. 70 or No. 80 Maxolite type, which is used in all of Central Electric steel reflectors. The threaded portion for the reflector fits the standard railroad line so that this hood can be used with any size reflector having the RR threaded neck.

This fixture is readily adaptable for in the construction of concrete building where quality and permanence are the deciding factors. The box can be drilled and threaded for conduit and put in place before the concrete is poured, the general arrangement being as shown in the sketch. This gives a substantial and lasting conduit system, and eliminates the use of extra fittings necessary to hold the reflector. An additional advantage is obtained where there is very little head room as in such an installation an RLM reflector with a two hundred watt lamp does not extend more than seven inches below the ceiling line.

Safety Handle for Portable Extensions

A socket and cord protector made of rubber for portable extensions, which is known as the Universal Safety Handle, is being marketed by the Industrial Products Company, Philadelphia, Pa. The handle is slipped on to the cord before the socket is applied, and after the socket has been attached the handle is pushed down over the

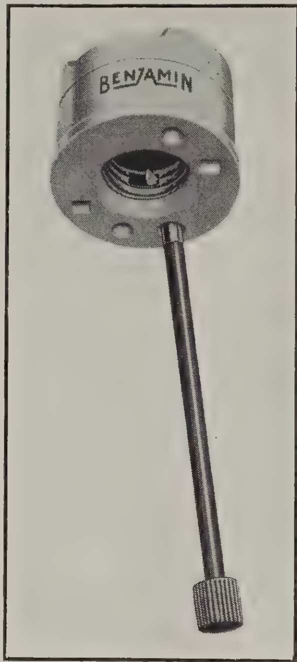


The Handle Provides Insulation and Mechanical Protection

socket and held in place by giving it one or two turns to the right. It can be used with either key or keyless sockets and with or without a lamp guard. The advantages claimed for the guard are that it prevents the cord from breaking and short circuiting at the handle, that it protects the lamp from shock and that it weatherproofs the socket, protecting it from water and acid.

Self-Locking Socket

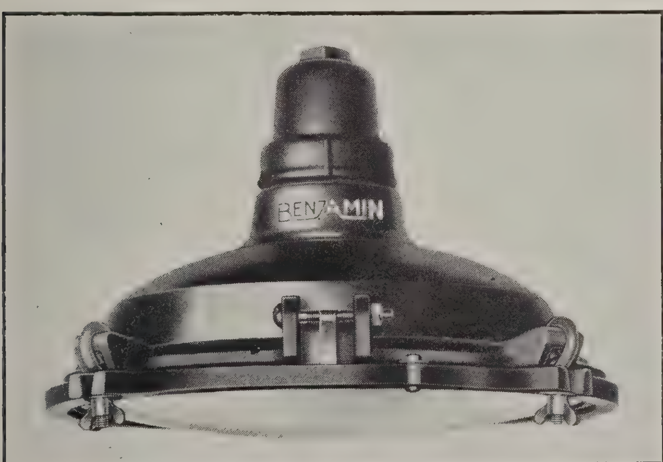
A self-locking socket with a key release has been placed on the market by the Benjamin Electric Mfg. Co. The socket is similar to the standard socket used in industrial lighting fixtures, but has a dog which projects through a slot in the socket shell. When the lamp bulb is screwed into the socket this dog is pushed down out of the way, but when an attempt is made to unscrew the lamp, the dog bites into the lamp base and makes it impossible to unscrew the lamp without breaking the bulb. When it is necessary to renew a lamp the dog can be released by a special key on an installating handle which is inserted into the socket, as shown in the illustration. The self-locking socket, designated as No. 86, is designed for medium base lamps and is for use only with Benjamin Reflector Sockets and fixtures with which the No. 88 two-piece porcelain socket is regularly supplied. The body only of the self-locking socket No. 586 may be easily substituted for the body of socket No. 88 in fixtures now in use. Additional keys may be purchased only on order of an executive officer.



Self-Locking Socket and Key

A Cover for R L M Reflectors

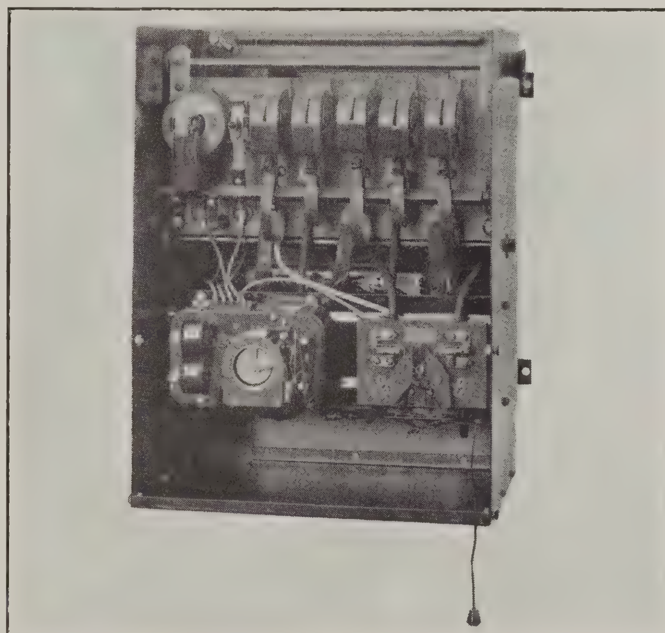
A cover for R L M type reflectors has been designed by the Benjamin Electric Mfg. Co. The purpose of the cover is to protect the reflector from dirt and corrosion and to make cleaning of the unit easy. It consists essentially of a piece of crowned clear glass covering the entire bell of the reflector held in place by a two-part aluminum holder. The upper half of the holder slips into place over the reflector bead and the lower half containing the glass and a circular rubber gasket is clamped rigidly to the upper part. The cover is hinged to facilitate the changing of lamps. The covers are furnished for 14, 16 and 18-in dome reflector sockets, for 14, 16 and 18-in. type RR dome reflectors and for 14-in. type RR fluted bowl and symmetrical angle reflectors.


Type R. L. M. Reflector Fitted with a Glass Cover

Starting Compensator

A new automatic starting compensator, type CR-7051-J1, for squirrel cage induction motors, will soon be placed on the market by the General Electric Company. This motor starter is for remote control of constant speed two- or three-phase squirrel-cage motors up to 600 volts for general application driving line shafting, pumps, compressors, blowers, conveyors, etc. With it, such equipments may be started or stopped from a distance by means of one or more small hand-operated push-buttons or snap switches located within convenient reach of the operator or automatically operated by pressure governor, float switch, thermostat, etc.

Various new and important features have been incorporated in the new compensator. Definite and adjustable time acceleration is obtained by means of a new induction type relay. Positive overload protection of the complete equipment is obtained by a double-pole, inverse-time temperature overload relay. The starting and running magnetic contractors are mounted back-to-back in a sheet steel enclosing case providing easy access to all parts. Several taps on the auto-transformer provide for adjusting the low voltage, for starting to suit the requirements of different installations.


General Electric Type CR-7051-J1 Starting Compensator for Squirrel Cage Motors with Cover Removed

All parts are protected by the steel enclosing case and a conduit box at the back has several knock-outs and furnishes entrance for all power and control wires to the motor starter. It is designed for sizes up to 50 horsepower, two- or three-phase.

General News Section

The Weston Electrical Instrument Company, Newark, N. J., has changed its name to the Weston Electrical Instrument Corporation.

The Electric Service Supplies Company, Philadelphia, Pa., announces the change in the name of one of their products. The commutator smoothing stone, formerly known as the Aetna stone, in the future will be called the Cass commutator stone.

In a decision recently handed down by the Court of Appeals in the District of Columbia, the Electric Arc Cutting & Welding Company, Newark, N. J., has won a decision pertaining to alternating current transformer arc welders which is 100 per cent favorable to the claims of Claude J. Holslag, chief engineer of the company.

Seventy-five per cent of all motors now manufactured by Fairbanks, Morse & Company are ball-bearing motors, according to an announcement made by A. W. Thompson, general manager of the Indianapolis plant, at a recent sales convention.

The Chicago, Burlington & Quincy has petitioned the Interstate Commerce Commission for an extension of time to June 30, 1925, to complete the automatic train control installation required by the commission's order of 1922. The company has let a contract to the Sprague Safety Control & Signal Company which guarantees compliance with the commission's specifications.

The tug boat "dispatcher" who regulates the operations of the boats of the New York Central in New York harbor is making the experiment, in co-operation with the Radio Corporation of America, of sending his orders to a boat by radio. This experiment, which is to continue for a month, is carried on in connection with tug No. 18, that boat having been fitted with a sending apparatus. The code signal of the tug is KFTQ.

The paper bought by the Pennsylvania Railroad for use during the year 1924 has aggregated an estimated quantity equal to 915,720,117 standard size letter sheets; which number of sheets, laid end to end, would extend 144,526 miles. The storekeeper who makes this estimate calls attention to the costliness of paper—sometimes for a brief period it costs more than the cost of rails—and asks that scratch pads be used on both sides.

The Missouri Pacific has established a complete additional train to be run as a second section of its Sunshine Special, southbound. Under the new arrangement the first section will carry passengers for north and west Texas points and the second section through passengers for south Texas and the Mexican gateway at Laredo, Texas. Through an arrangement with the Southern Pacific a St. Louis-Los Angeles through sleeper will be added to the first section, connection being made at El Paso, Texas. A through St. Louis-Hot Springs sleeper and a Memphis-Los Angeles sleeper also will be run.

Three thousand nine hundred dollars is the monthly saving which has been made by the Lehigh Valley by discontinuing the operation of a local freight train between Ithaca, N. Y., and Geneva, about 40 miles. This is the report by the automobile people, who say that since the substitution of a truck and trailer on the highway, to care for this local merchandise movement, there has been a decided reduction in the damages to goods; this because "small consignments were knocked about by frequent stopping of the freight cars." The cost of operating a freight train was, according to this statement $4,816 a month, as compared with $900 a month which the railroad company pays to the truck operator.

An inspection of one of the units of the largest electric locomotives in the world by officials of the Virginian Railway, American Locomotive Works, and the Westinghouse Electric & Manufacturing Company was made at the Main Works of the Westinghouse Company recently. The locomotive, recently built by the American Locomotive Works, arrived at East Pittsburgh where the electrical equipment will be installed for the Virginian Railway by the Westinghouse Company. Three motive power units comprise one electric locomotive making the largest locomotive in the world. At present some of the heaviest tonnage trains are now being hauled on the Virginian Railway but the completion of the new locomotives will permit the hauling of trains of even greater tonnage.

Radio Aids Against Storm

The radio played an important part in the western railways struggle against the snow storm and extremely cold weather which swept over the country recently. At one time or another virtually all of the Chicago broadcasting stations assisted the railways in locating trains which could not communicate with headquarters on account of breaks in the telegraph lines. The disruption of the telegraph service was the worst handicap that the railroads had to contend with, as there was not a heavy snowfall except in the northwest, where trains on all lines were delayed from one to several hours. The severe cold, however, caused numerous engine failures so that many trains were far behind time. The lines running from Chicago to St. Louis were particularly hard hit.

Train Control Proprietors to Amalgamate

Preliminary steps toward the organization of the Amalgamated Train Control Sales Corporation were taken at a meeting of representatives of train control companies and proprietors of train control devices held at Washington on December 15. It is proposed to give the sales corporation the exclusive sales and production agency for the various companies under a co-operative plan by which the railroads

may be offered the benefit of any combination of the devices and patents controlled by the different companies, which are not to lose their identity. A committee was appointed, with James William Bryan of Washington as chairman, to work out further plans and take the necessary steps toward incorporating the company, and another meeting will be held later. The railroads have been asked to appoint a board of engineers to meet with a board of engineers representing the train control companies in an effort to work out, by combination of the various patents, a device which will meet the requirements of the roads and of the Interstate Commerce Commission. The committee of railway executives has promised to co-operate in any way that seems advisable.

Ask Extension of Time for Train Control

Petitions for a postponement of the effective date of the Interstate Commerce Commission's order of June 13, 1922, as modified by its order of July 18, 1924, requiring installations of automatic train control, have been filed with the commission by the Lehigh Valley, the Cincinnati, New Orleans & Texas Pacific and the Southern.

In the petition of the C., N. O. & T. P., and the Southern, it is stated that 35.5 miles between Ludlow and Williamstown, Ky., have been equipped with the auto-manual type of inductive train control and that the equipment is now ready for inspection by the commission, and that this has been asked for; and that, until this installation and its performance under actual operating conditions have been inspected and observed by the commission's representatives and a report made, the petitioners hesitate to go forward on a major scale with the work of equipping the remaining mileage required by the order. Therefore, further time is asked in which to comply with the mandate of the order, and it is stated that if the present installation is approved the roads will proceed as rapidly as possible to equip the remaining mileage as required by the order.

The Lehigh Valley petition asks for a postponement of the effective date for six months. It says that a contract has been made with the General Railway Signal Company for the installation of the auto-manual system between Easton, Pa., and Newark, N. J., and that the full roadside equipment has been installed between Phillipsburg and Flemington Junction, N. J., over 20 miles, while ten locomotives have been equipped. This, the petition says, constitutes a bona fide effort to secure and install a device that will comply with the commission's order, and warrants additional time to complete the work.

Final Inspection of Train Control on C. & E. I.

The Interstate Commerce Commission has completed arrangements to begin the final inspection and test of the Miller automatic train control installation on the Chicago & Eastern Illinois.

Additional railroads have filed petitions with the commission asking an extension of time in which to complete their installations of automatic train control, which, under the commission's order, were to be completed by December 31, 1924.

The New York, New Haven & Hartford has asked for an extension until January 1, 1926. After outlining its experiences in experimenting with different devices the petition says it was found necessary to make changes and that that part of the line from Cedar Hill to Berlin, Conn., 23.2 miles is practically complete.

The Pere Marquette has asked for an extension until February 6, 1926, saying it is expected that the installation can be completed by that time. It has been decided to adopt the intermittent induction type for installation between Seymour, Mich., and North Lansing, Mich. The petition says that unified operation and control of the Pere Marquette; the New York, Chicago & St. Louis; the Chesapeake & Ohio; the Hocking Valley, and the Erie is under consideration, and that conferences among the officers of these roads have developed that this type of train control, manufactured by the Union Switch & Signal Company and the General Railway Signal Company, will probably best meet the requirements and permit interchange of equipment. It is expected to let the contract to one of these companies for the first 20-mile section.

The petition of the Delaware & Hudson, though in terms a request for exemption, really asks for extension of time; for, as stated, the company proposes to proceed as rapidly as possible with the experimental installation which has been begun on the line from Rouse's Point, N. Y., southward. The length of this installation is 20 miles. The chief reason given for asking for an extension of time, aside from the general undeveloped state of the art of automatic train control, is that, until the issuance of the order of July 18, 1924, the company had been trying to perfect a train control device (speed control), whereas that order, by permitting the use of a train stop subject to manual control, led to a change in the company's plans. The company further avers that until the automatic stop is further developed, the use of such a system, on its lines now equipped with automatic (visual) block signals, is likely to impair the efficiency of the block signals; is more likely to increase danger than to decrease it.

Special Football Train Across the Continent

The special train started by the Pennsylvania on December 26 for California to carry the University of Pennsylvania football team to Berkeley stadium for the game with the University of California on New Year's Day, one of the longest trips ever made in football history for a single game was called a unique train. A baggage car was provided, fitted up as a gymnasium for exercise and for shower baths. In the dining car the team and substitutes were provided approved training table meals, while the regular dining car service was available for other persons in the party. The train had one 16 section sleeping car for the university team exclusively, and four 12 section sleepers and one seven compartment sleeper for other members of the party; also a special car for the chairman of the university council on athletics and his party. The dining car crew were accommodated in a combined car fitted up with bunks.

From Chicago the train went over the Chicago, Milwaukee & St. Paul, the Union Pacific System, and reached Ogden, Utah, at 2:00 p. m., Monday, December 29th. Leaving Ogden by the Southern Pacific arrived at Berkeley, Cal., on Tuesday, December 30, at 1:39 p. m. The game was held on Thursday, January 1. On Thursday night the party left San Francisco at 8:15 p. m. on the Southern Pacific for Los Angeles and Hollywood.

The return was over the Atchison, Topeka & Santa Fe and the Pennsylvania. Stops were made at Grand Canyon, Arizona, and Albuquerque, N. M.

C. B. & Q. Purchases Electric Welding Equipment

Following a long and intensive study of the relative merits of gas and electric welding, the Chicago, Burlington and Quincy Railroad has decided in favor of electricity and has taken the first step in supplying its erecting shops and enginehouses with this type of equipment. Forty-five portable electric arc welders have been purchased from the General Electric Company.

The welding equipments are of rather unique construction. Each outfit is a WD-12 welder, a portable outfit recently put on the market.

Personals

T. R. Langan has been appointed manager, transportation division in the New York office of the Westinghouse Electric & Manufacturing Company to succeed A. J. Manson recently promoted to manager, heavy traction division of the railway sales department at East Pittsburgh, Pa. Mr. Langan was formerly manager of the transportation section in the Buffalo, N. Y., district. After taking courses at Pratt Institute, Brooklyn, N. Y., and while taking night courses at Carnegie Institute of Technology, Pittsburgh, Mr. Langan entered the employ of the Westinghouse Company in 1904 as an armature winder's helper and wireman's helper in the service department. From 1904 to 1906 he worked on the earlier installation of multiple unit control equipments on the Brooklyn Elevated and New York subway. In 1906 he began the special apprenticeship course at the East Pittsburgh works. After taking up construction work in the service department in 1908, Mr. Langan was made assistant general foreman of maintenance on the electric division of the New York, New Haven & Hartford, with headquarters at Stamford, Conn. In 1910 he returned to East Pittsburgh on special service and engineering work in connection with the development of the present line of Westinghouse HL control and railway apparatus. In 1913 Mr. Langan entered the sales department at Baltimore, Md.; he subsequently went to Philadelphia, Pa., then to Buffalo, N. Y., later to Syracuse and finally to his present position in New York City.


T. R. Langan

C. R. Stover, formerly at the National Lamp Works of the General Electric Company, at Nela Park, Cleveland, has been transferred to Sunbeam, Inc., Lamp division, with headquarters in Chicago. Mr. Stover's work will not be unlike that which he did at Nela Park, and this consists chiefly of handling commercial and engineering service of the railway customers who are supplied by the Sunbeam division of the company.

Frank W. Edmunds, for the past several years eastern representative at New York City of the Sunbeam Electric & Manufacturing Company, Evansville, Ind., has severed his connection with that company effective January 1. Mr. Edmunds' address is West Nyack, N. Y.

Henry W. Darling, for more than 30 years treasurer of the General Electric Company, Schenectady, N. Y., resigned on January 1 and has been succeeded by R. S. Murray, who has been assistant treasurer of the company since 1910. In accepting the resignation of Mr. Darling as treasurer, the board of directors elected him a vice-president with such duties as shall be assigned to him by the president.

Trade Publications

Cutler-Hammer Electric Elevator Controllers is the title of a 48-page booklet published by The Cutler-Hammer Mfg. Company of Milwaukee, Wis. This booklet, which is known as publication No. 3082, illustrates and describes many types of elevator control apparatus for passenger and freight elevators.

Sangamo Electric Company, Springfield, Ill., in its recently issued bulletins Nos. 67 and 68, illustrate and describe alternating current watt-hour meters and type N ampere-hour meters respectively. Each of the bulletins contains many illustrations which show clearly the design and construction of the respective instruments.

Bulletin No. 48941A, entitled "Cr-9006 Enameled Resistor Units," has been issued by the General Electric Company. This is a well illustrated booklet describing the uses and advantages of these units and giving standard ratings and dimensions. Applications are given for several different fields of service. The bulletin contains 18 reading pages.

Roller Smith Company, New York, recently issued four new bulletins, Nos. 100, 200, 430 and 550. These bulletins supersede others previously issued on the same subjects. The titles are, respectively, "Electrical Instruments for Signal System Testing," "Rail Bond Testers," "Direct Current Switchboard Instruments" and "Direct Current Relays."

Electric Arc Cutting & Welding Company, Newark, N. J., has recently issued an illustrated booklet of 52 pages describing the portable welding and cutting apparatus manufactured by the company. While the equipment described is essentially designed for use on alternating current circuits, it is quite possible to use it on direct current circuits as well.

Meter Clocks.—Bulletin No. 724 descriptive of meter clock improvements and a new recorder for low air, gas, steam or water pressures, has been issued by the Esterline-Angus Company, Indianapolis, Ind. The graphic KVA. meter, which is used to study the subject of KVA. demand rates and for measuring the loads of consumers billed under a power factor clause, is also illustrated.

Railway Electrical Engineer

Volume 16 FEBRUARY, 1925 No. 2

The Train Control Triangle

Automatic train control is one of the most vexatious problems with which the railroads have been confronted. Considering the number of automatic train control systems available, together with the fact that most of them have not had an opportunity to demonstrate their capabilities, it is not surprising that the carriers are installing them reluctantly. The installation of this equipment is, however, mandatory on those roads included in the Interstate Commerce Commission order and it will be very much to the advantage of the roads to see that it functions in the proper manner.

Train control is a three-sided problem. First, the indication must be picked up from the roadside; second, it must be communicated to the braking system by some means, usually electric, and third, the operation must culminate in the application of the brakes. The indication from the roadside may be considered as within the province of the signal department, as the apparatus used along the track is almost invariably interconnected with the signal system. The transfer of the indication from the roadside to the braking equipment, at least where this is done by electric circuits, falls within the scope of the electrical department, and finally the actual operation of the air brake equipment is unquestionably a matter for the attention of the air brake department.

From the very nature of the equipment and its application, it is plainly evident that there exists a joint responsibility which cannot be disregarded. The signal, electrical and air brake men are involved in the successful operation of any automatic train control system. In planning for the selection, application and maintenance of automatic train control equipment it is important that these three departments be adequately represented since in but very few cases will men be found whose experience and training include an up-to-date working knowledge of such a wide range of activities.

Rubber Battery Jars

The use of rubber battery jars for car lighting systems cannot be looked upon as something which is new, for long ago jars made of this material were used. It is to be noted, however, that rubber battery jars did not continue in vogue and were very largely supplanted by lead tanks. The reason why this change was made was probably due to the use of poor material in the construction of the rubber jars. In the early days neither the jar manufacturers nor the users knew as much as they should about train lighting requirements and due to price competition inferior jars came on the market. These jars would not stand up in the service they were designed for and the result was that failures became so frenquent that extensive use of rubber jars was discontinued on all railroads but one. Nor was the lead container which took their place a "cure-all." Electrolytic action plays havoc with lead tanks and they require much inspection and repair.

The rubber jar is again being looked upon with favor by many who are of the opinion that when the right kind of material is used in their construction the rubber containers will eventually displace most of the lead ones. It is possible to manufacture rubber jars of such high quality that the amount of breakage is very low. Electrolysis is, of course, eliminated and leaky tanks, due to this cause, are no longer a factor in maintenance. The question involved in the selection of rubber jars thus becomes one of balancing the cost of high grade jars against the cost of maintenance of those of lower grade. It may prove that the very highest quality is not required in the manufacture of rubber jars. As a matter of fact, one road which uses a lower quality rubber jar is successful in keeping its battery maintenance cost to a low figure.

It is evident that there are certain characteristics of rubber jars which are desirable and if these can be secured at reasonable cost, there is great probability that hard rubber battery containers will entirely supplant the lead lined tank.

The Turbo-Electric Locomotive

The Ramsay turbo-electric locomotive described elsewhere in this issue is in many ways an innovation in the motive power field. A condensing steam turbine is used to drive an alternating current generator and electrical energy from the generator is supplied to wound rotor induction motors which can be connected either in cascade or multiple. The driving wheels are driven by the motors through gears and side rods.

The outstanding advantage of the turbine is that it is much more efficient than the cylinders of an ordinary non-condensing locomotive. The condenser requires a large space, but this is in part at least offset by the smaller amount of make-up water that need be carried. Although it takes a pound of water on the outside of the condenser tubes to condense a pound of steam inside, due to the

greater efficiency of the condensing turbine, considerably less tank capacity is required as compared with an ordinary locomotive of the same power.

As compared with an electric locomotive, the most important factor which operates in favor of the Ramsay machine is that transmission and distribution losses are eliminated. The operating characteristics are much the same as those of a three-phase electric locomotive, but greater flexibility is obtainable as the operator can control the generator frequency by controlling the speed of the turbine. There is one running speed, with resistances cut out, of 15 miles an hour and any running speed is available from 30 to 60 miles an hour.

Undoubtedly the turbo-electric locomotive is handicapped by its complexity, but it was built as an experimental unit and not with the idea that it is immediately to replace all other types of motive power. The locomotive exemplifies the effort which is being made to get the most out of both steam and electric motive power and it provides in a single unit a wonderful opportunity to study the characteristics of both steam and electric equipment as applied to a locomotive.

Train Control Maintenance

The first automatic train control order issued by the Interstate Commerce Commission is being complied with, and when the work is completed the investment will amount to approximately $32,000,000, including additions and changes to existing signal systems. When completed, 8,360 miles of track will be equipped on the 46 railroads which have not been exempted from the order. Up to January 1, 1925, automatic train control installations were actually in operation or under construction on 3,592 miles of track, or 42 per cent of the total mileage covered by the order. Some extensions of time when the work must be completed have been granted; in most of these cases the final date has been made July 1, 1925.

While complying with the order the railroads continue to protest that not enough is known about the equipment to warrant such extensive installations. Much can be learned by inspecting a piece of apparatus and studying the principle of its operation but, in the last analysis, "the proof of the pudding is in the eating"; the apparatus must be tried out in regular service before its real value can be definitely established.

Three railroads had completed the required installation on a passenger division on January 1, 1925. These were the Chicago, Rock Island & Pacific, the Chicago & Eastern Illinois, and the Chesapeake & Ohio. The Rock Island installation, however, is the only one which had received the approval of the commission. It is fitting, therefore, that the first information concerning the practical operation and maintenance of train control equipment should appear in the form of an article by Ernest Wanamaker, electrical engineer of the Rock Island, which is published elsewhere in this issue. This article is of general use since it describes maintenance methods and a maintenance personnel such as might be used for any system. It is specifically useful for those using Regan apparatus. It is to be hoped that more men in a position to prepare similar information concerning experiences on other roads and with other makes of equipment will do so.

Maintenance of Lighting Units

The loss of light due to dirty lamps and reflectors is seldom actually measured, although where tests have been made they show that a very large portion of the energy fed into lighting circuits is never used in the production of light. Dirt accumulates very rapidly in shops where there is usually more or less smoke in the atmosphere and it is only by diligently keeping after the lighting units, that they can be kept at their maximum efficiency. Unless some consideration is given to the maintenance of reflectors and an endeavor made to keep them clean, it would seem a waste of money to purchase them. Dirt will collect on both lamp and reflector and these must be given a thorough cleaning, periodically. There are many conditions under which lighting units are installed. These conditions are usually the determining factor in the kind of equipment used. In roundhouses, it is considered desirable to have the lighting units approximately 12 feet above the floor or below what is known as the gas line. Fixtures so located will be less subject to the deteriorating influences of the gas found in these buildings. In cleaning such lighting equipment, a suitable step ladder forms one of the essential requirements. It is not practicable to use any type of lowering device for conditions found in the average roundhouse, since very frequently it is found advantageous to mount the lighting units on the sides of posts or walls.

In other buildings, where on account of different conditions it is necessary to hang the lighting fixtures high above the floor and frequently in places which are not readily accessible, it is often desirable to use some form of lowering device so that the lamp and reflector may be lowered to a position where they can be easily cleaned without introducing any personal hazard of the lamp cleaner. Unless means are provided by which lamps in difficult positions are made easy of access, there is every tendency to neglect such lamps which will inevitably result in the loss of illumination from these particular units.

New Book

Electrical Engineering by A. L. Hazeltine, professor of Electrical Engineering, Stevens Institute of Technology, 625 pages, illustrated diagrams and tables, 5½ in. by 8½ in. Bound in cloth. Published by the Macmillan Company, New York.

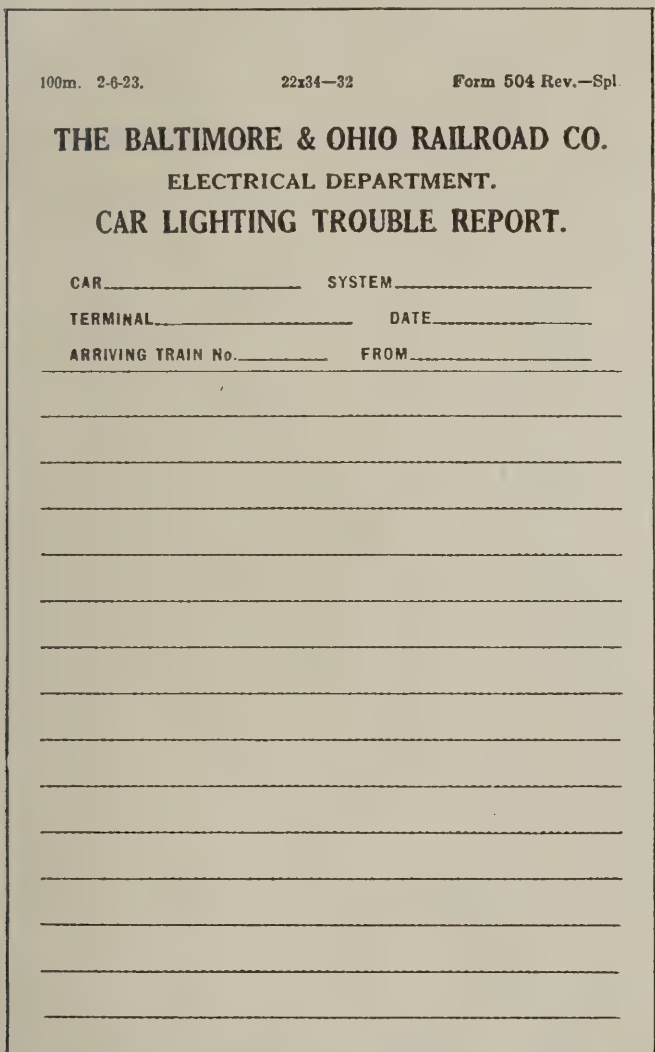
The book is an attempt to put into a single volume the essential elements of electrical science and its applications to the various branches of electrical engineering. It is primarily a college text book and is not well suited for self-study. The subject matter of the book has for its basis the material used in the author's classes in electrical engineering at the Stevens Institute of Technology. There are fifteen chapters in all and the subjects which are treated in varying degrees of detail, are, fundamentals of physical relations, electric conduction, electro-statics, electro-magnetism, alternating currents, transient currents and electric waves, conduction of gases and electrolytes, electric measuring instruments, electrical measurements, direct current machines, synchronous machines, induction machines, transformers, transmission and distribution and electrical communication.

Baltimore & Ohio Car Lighting Record System

Complete Instructions for Each Class of Inspection Work Make Uniform Maintenance Possible At All Terminals

IT is not to be expected that the methods of maintaining electric lighting of cars will be the same on all roads, and it is interesting to study, from time to time, the various practices that the different roads have developed to meet the problems with which they are daily confronted.

Aside from the actual maintenance work the methods used in keeping records are most interesting. In a number of respects the Baltimore & Ohio Railroad have developed a system of car lighting maintenance and record keeping which is, to say the least, unique.



100m. 2-6-23. 22x34—32 Form 504 Rev.—Spl.

THE BALTIMORE & OHIO RAILROAD CO.

ELECTRICAL DEPARTMENT.

CAR LIGHTING TROUBLE REPORT.

CAR________ SYSTEM________

TERMINAL________ DATE________

ARRIVING TRAIN No.________ FROM________

Daily Inspection Report or Ticket Showing Individual Attention Given to Any Particular Car. One of These Tickets Corresponds to Each X on the Large Daily Inspection Report—Form 515—B Rev.—Spl.

In the first place it may be well to say a word about the car lighting organization on the Baltimore & Ohio. While car lighting work on the Baltimore & Ohio is organized on the divisional basis it is supervised and practically maintained on a departmental basis. Electricians, helpers and apprentices engaged in the work of maintaining electric lights are carried as a part of the regular forces of the various divisions upon which they are located. The car lighting men are a part of the electrical maintenance forces and as such report to the local motive power department supervisory forces.

In spite of this apparent scattering of the maintenance under various jurisdictions, the actual responsibility for the satisfactory performance of the work is centered in the electric car lighting supervisor who is located in Baltimore, and it is to him that all reports are forwarded for record-keeping purposes. All orders regarding the care of the equipment are also issued from the office of the car lighting supervisor, such orders being sent to the division master mechanics, and thence transmitted through the divisional channels to the car lighting electricians at that point. In emergency cases where it is necessary to expedite matters, the car lighting supervisor will send the orders in duplicate, one copy going directly to the electricians who can immediately begin the work requested without waiting for the same order to come through the regular channels, which is frequently slower.

At New York, Washington, Louisville, St. Louis and Chicago, the work is handled by terminal companies who are equipped with car lighting maintenance organizations.

Electric Car Lighting Instructions

In order to effect uniform methods of inspection and maintenance throughout the entire Baltimore & Ohio system, certain rules or instructions were issued by the supervisor of electric car lighting and these instructions serve as a guide to the various electricians regardless of where they are located. Although these instructions are of considerable length it is believed that they will afford a valuable opportunity for the comparison of other methods and for this reason they are given here practically in full.

Baltimore and Ohio Railroad Company Electric Car Lighting Instructions

GENERAL

These instructions will cover standard practices to be followed in connection with operation and maintenance of electric lighting of passenger equipment cars, for the lighting of which the Baltimore and Ohio Railroad is responsible. These instructions are to take effect as soon as issued unless otherwise specified, superseding all previous instructions pertaining to the same subject in whatever form isued. They are to be followed thereafter until superseded or recalled.

FORMS FOR REPORTS

The following forms, exclusive of those required for accounting purposes, are to be used for making reports in connection with the operation and maintenance of electric car lighting:

FORM NUMBER	DESCRIPTION
515-B-Rev.-Spl.	Daily Inspection Report:
504-Rev.-Spl.	Car Lighting Trouble Report, etc.:
515-Spl.	Trip Report of Condition of Electric Lights:
509-B-Spl.	Monthly Record of Current Used for Charging Car Lighting Batteries:
504-A-Spl.	Transfer of Lighting Equipment:
F-11	Monthly Performance Report:
508-B-Spl.	Periodical Inspection Report Tag:

Daily Inspection Report of Electric Car Lighting Equipment Form 515-B-Rev.-Spl.

This form covers record of inspection of electric lighted cars at terminal and division points and is to be used at all points where there are stationed Electric Car Lighting Repairmen. The following information is to be entered on this report for all electrically lighted cars (the lighting of which is maintained by the Baltimore and Ohio Railroad, except where special instructions are issued to the contrary):

(1) The names or numbers of all electrically lighted cars arriving and departing from, or laying over at terminal in question, during 24-hour periods beginning at midnight. At division points, record is to be made of electrically lighted cars on passing trains (unless special instructions are issued otherwise).

The arriving train numbers shall be given only in case the car arrives during the 24-hour period covered by the report, and similarly with departing trains. In case car arrives and departs on same date, both train numbers shall be shown on the same report.

(2) Arriving voltage (see voltage tests class "A" inspection) and ampere hour meter readings (if car is equipped with ampere hour meter) are to be shown on arrival of all cars, but the departing voltage and ampere hour meter readings are not to be shown (except as noted in next paragraph) unless car lays in terminal for a period of 24 hours or more, or unless batteries are charged during the layover. In the latter case, if car is equipped with ampere hour meter, ampere hour meter readings are to be taken before and after charging.

(3) The voltage (see voltage tests class "A" inspection) and ampere hour meter readings (if car is equipped with ampere hour meter) are to be shown on all layover, cars every 24 hours (unless special instructions are issued otherwise) and also the departing voltage and ampere hour meter readings on all official cars before departure.

(4) If inspection shows that the various parts of the equipment are O. K., no marks need be entered in columns under such parts. If trouble is found in any of the parts, or if it is necessary to charge the batteries (X) mark should be made in the proper column and detail report of the trouble made on Form 504-Rev.-Spl. Record of charging current is to be made on Form 509-B-Spl.

(5) Other matters to be entered on this form will be found under subjects, "class A," "class B," and "class C" inspections.

This form must be made out daily, at each terminal and division point, by the electric car lighting repairman or repairmen (where there is more than one shift), and signed by same, or by the electric car lighting foreman (where same exists) and mailed daily to the Electric Car Lighting Supervisor, Baltimore, Md.

Car Lighting Trouble Report—Form 504-Rev.-Spl.

Wherever trouble is found with any part of the equipment or where the voltage of the lamp circuit is 25 volts or less, separate detail report of same should be made out for each car on this form, and forwarded to the Electric Car Lighting Supervisor along with daily inspection report Form 515-B-Rev.-Spl., specifying in particular if car was trainlined or not, and if voltage was taken with trainline jumper connected up).

Several of these blank forms are also to be kept in the card holder in the electric locker on each electrically lighted car, for use of the train crew to report any trouble experienced with the lights on line of road. Where such reports are made, they are to be removed by the electric car lighting repairman at the arriving station, and after noting on the report what action was taken to remedy the trouble, should be forwarded with daily inspection report to the Electric Car Lighting Supervisor, Baltimore, Md.

Trip Report of Condition of Electric Lights—Form 515-Spl.

This form is for reporting condition of electric lights on line of road and until further instructed, is to be used only on dining and cafe cars. Reports are to be made out at the end of each trip by the dining car steward, and forwarded to the Electric Car Lighting Supervisor, Baltimore, Md.

Monthly Record of Current Used for Charging Car Lighting Batteries—Form 509-B-Spl.

This form is to provide a record of all current used for charging car lighting batteries at terminal points. Information called for on this form is to be filled out for all cars charged during the month at terminal in question, and forwarded to the Electric Car Lighting Supervisor, Baltimore, Md., at the end of the month.

Transfer of Lighting Equipment—Form 504-A-Spl.

This form is for reporting all changes in the location of car lighting equipment, i. e., application to or removal from a car, shipment to or receipt from any other point. Information called for on this form must be made out whenever transfer is made by the terminal making the transfer and report forwarded at once to the Electric Car Lighting Supervisor, Baltimore, Md.

Periodical Inspection Report Tag—Form 508-B-Spl.

This tag is for noting dates of periodical inspections of lighting equipment, greasing dates of generators, flushing of batteries, height of solution in storage batteries, etc. This tag is to be carried in electric locker of each electrically lighted car. When tag is filled, it should be removed by electrician making last report and forwarded to the Electric Car Lighting Supervisor, Baltimore, Md., and replaced by a new tag. The last greasing date of generator, and the last inspection date of battery on old tag, are to be carried forward as first dates on new tag.

Monthly Performance Report—Form F-11.

This report covers a summary of the performance of car lighting equipment and is to be prepared each month by the office of the

10m. 9-2-24. 22x34-40 Form 515-B Rev.—Spl.

THE BALTIMORE AND OHIO RAILROAD COMPANY

ELECTRICAL DEPARTMENT

DAILY INSPECTION REPORT OF ELECTRICAL CAR LIGHTING EQUIPMENT

Terminal ______________ Date ______________

CAR NAME OR NUMBER	ARRIVING TRAIN No.	DEPARTING TRAIN No.	SYSTEM LIGHTING	ARRIVING			DEPARTING			INSPECTION										
							VOLTS													
				BATTERY	LAMPS	AMP. HOURS	BATTERY	LAMPS	AMP. HOURS	GENERATOR	PULLEYS	BELT	SUSPENSION	GENERATOR REGULATOR	LAMP REGULATOR	FUSES	LAMPS	FANS	BATTERY	KIND OF INSPECTION

This Is the Large Daily Inspection Report Sent in to the Electric Car Lighting Supervisor From the Various Centers of Maintenance. The Actual Size of the Sheet Is 8½ In. by 11 In.

Electric Car Lighting Supervisor and forwarded to the Chief Engineer of Electric Traction as soon after the first of the month as possible.

Class "A" Inspection—Daily Terminal Inspection of Electrically Lighted Cars

The following inspection shall be made daily by electricians, of electrically lighted cars, the lighting of which is maintained by the railroad, at the layover points of the cars.

Voltage tests are to be made, and ampere hour meter readings

25m 6-4-23 22x28 110 Form 515 Spl.

THE BALTIMORE & OHIO RAILROAD CO.

ELECTRICAL DEPARTMENT

TRIP REPORT OF ELECTRIC LIGHTS

*Train*__________ *Date Leaving*__________

CAR	FROM	TO	CONDITION OF LIGHTS				
			O. K.	Unsteady	DIM		Gas Used
					All the Time	When Not Running	

REMARKS

____

____

____

____

SIGNED

This report to be made out by Dining Car Conductors, Mail Clerks for their respective cars, and by each train conductor at the end of his run, for other cars. Mail to W. W. LEONARD, Electric Car Lighting Supervisor, Camden Station, Baltimore, at end of each run.

This Form Is Post Card Size and Is Mailed into the Electric Car Lighting Supervisor as Railroad Business. A Record Is Compiled From These in the Supervisor's Office

taken (if car is equipped with ampere hour meter) upon arrival of all cars having batteries as follows:

With all lamps burning for about five minutes, readings are to be taken at switchboard, of (1) battery voltage, (2) lamp voltage, and (3) voltage between each side of circuit and ground to ascertain if wiring is grounded.

Voltage and ampere hour meter readings (if car is equipped with ampere hour meter) are also to be taken on layover cars every 24 hours (unless special instructions are issued otherwise), and the departing voltage and ampere hour meter readings on all official cars before departure, unless batteries are charged during layover. In the latter case if car is equipped with ampere hour meter, ampere hour meter readings are to be taken before and after charging.

Service switches, circuits, lamps, etc. Try all service switches to ascertain if they as well as the lamps and fans controlled therefrom are operating properly. Replace burned out or blackened lamps and broken or missing reflectors. See that all lamps are screwed firmly into sockets and reflectors are secure in shade holders. Examine all fuses, replacing defective as well as bridged fuses. See that contact surfaces of fuses and fuse holders are clean and make good connections. If voltage test for ground shows deflection of 10 volts or more, locate and remove ground.

See that all dining, official, combination, mail and baggage, and postal cars, are equipped with trainline jumpers, and in addition to these, that there are on each train (for trainlining coaches and baggage cars), as many trainline jumpers less (1) one, as there are coaches and baggage cars on train.

Regulating apparatus. Inspect all switches and other contact making parts to insure contacts engage properly and carbon breaks are in good condition, making adjustments or repairs where necessary. Inspect carbon pile rheostats, replacing defective discs.

See that resistance units, wire connections, etc., are in good condition and that all moving parts work smoothly.

Examine belts and belt fasteners to insure they are in good condition and that belt has proper tension. See that pulleys are on tight and are in good shape.

Suspension: Inspect generator support shaft or shafts, and determine if generator moves freely. (Lubricate when necessary.)

10m. 12-2-20. 22x34—30 Form 504-A—Spl.

THE BALTIMORE & OHIO RAILROAD CO.

ELECTRICAL DEPARTMENT.

TRANSFER OF LIGHTING EQUIPMENT.

Terminal__________ **Date**__________

The following Equipment was Transferred

From ____________________

To__________ **Date**__________

BATTERY

Make__________ **Owner**__________

Set No.__________ **No. of Cells**__________

GENERATOR, No.__________

Make__________ **Type**__________

GENERATOR REGULATOR, No. __________

Make__________ **Type**__________

LAMP REGULATOR, No.__________

Make__________ **Type**__________

LAMP REGULATOR RELAY, No.__________

Make__________ **Type**__________

FANS, No. __________ **Make**__________

Remarks : ____________________

____

____

____

Electrician.

Forward this report to Chief Electrician, Baltimore, whenever transfers to Lighting Equipment are made.

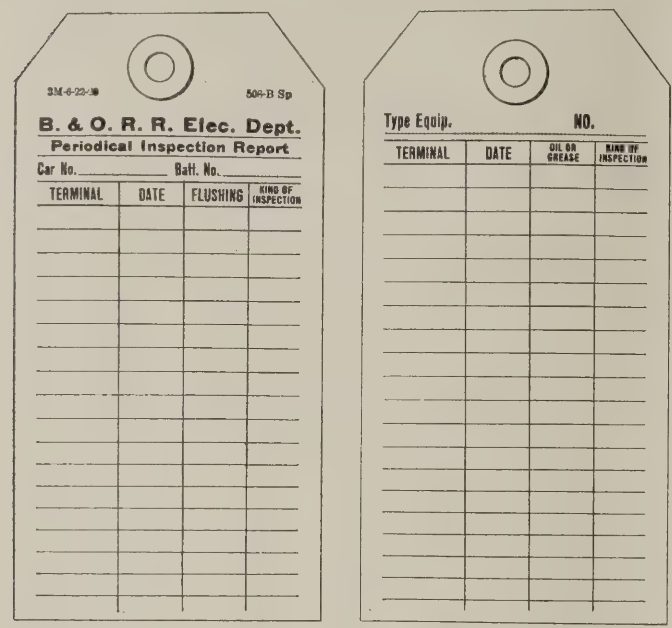
Form Used for Reporting All Changes in Location of Car Lighting Equipment

As a matter of safety thorough inspection must be made of generator, suspension and pulleys. Examine all bolts, nuts, rivets and cotters in the above parts to insure that they are tight and none are missing. Examine all suspension parts for defects in the material. Any defects found should be brought to the attention of car foreman and whatever repairs necessary to insure safety of the equipment must be made before car departs.

Battery: If battery voltage on car arrival is below normal, examine battery for cause, ascertaining that electrolyte is at proper

height and that none of the cells are in defective condition. Charge battery if necessary.

Close attention should be given to heights of solution in batteries as shown on Periodical Inspection Tag (Form 508-B-Spl.), and where height of solution was found to be two inches or less (above top of plates) on last class B inspection, batteries shall be inspected at period of ten days thereafter, and flushed if there is



Front and Rear of Tag Which Travels With the Car in the Locker Housing the Control Panel. The Illustration Is About Two-Thirds the Actual Size of the Card

any doubt as to whether same will fall to within one quarter inch of tops of plates, before the next class B inspection period is due.

General and reports: Repair any defects found in electric lighting apparatus, car wiring, fixtures, etc., before car departs. If for any reason it is found impossible to do so, report of same should be made out in duplicate on Form 504-Rev.-Spl., one copy to be placed in card holder in the electric locker of car for information of electrician at next terminal and other copy forwarded to Electric Car Lighting Supervisor, Baltimore, Md.

Reports of daily terminal inspections are to be made on Form 515-B-Rev.-Spl., and Form 504-Rev.-Spl., as covered by instructions for filling out these forms. Record of battery flushing should be noted on Periodical Inspection Report Tag Form 508-B-Spl.

Class "B" Inspection—Periodic Inspection of Car Lighting Equipment

The following periodic inspection of axle generating equipments in addition to class "A" inspection shall be made by electricians at intervals of 20 days at the layover points of cars.

Suspension: Inspect for proper alignment of axle generator with respect to axle pulley and adjust if necessary. Examine carefully all parts subject to wear, such as link pins, support shafts, etc. If play is excessive parts should be removed for further inspection and if badly worn must be replaced.

Inspect for interference of belt with any parts of truck or brake rigging. See that clearance is ample between any part of generator or suspension and car body or rail. Clearance between any part of equipment and head of rail should never be less than 4 inches. Any evidence of insufficient clearance should be reported to car foreman and necessary repairs made.

Generator: Remove hand hole covers and inspect fields, commutator, brushes, brush leads, pole changes, etc., repairing any defective parts. Give generator thorough cleaning. Replace badly worn or grooved pulleys. Slacken belt and motor generator in both directions. Speed generator by increasing field resistance. While machine is running at high speed open automatic switch and decrease field resistance to ascertain if automatic switch picks up. Examine leads connecting generator to car.

Lubrication: "Grease cups" on Stone Franklin generators are to be examined and screwed down two turns, unless conditions indicate more Greeoil is required, and are also to be kept well supplied with Greeoil at all times. When Greeoil is applied to cups, record is to be made on Periodical Inspection Report Tag, Form 508-B-Spl., marking same, thus, "Gr. Cups," in column marked "Oil or Grease," and reported on Form 504-Rev.-Spl., which is to be forwarded to the Electric Car Lighting Supervisor, Baltimore, Md.

High speed body hung ball bearing generators are to have heads removed, bearing housings opened for cleaning and regreasing every four months, slow speed truck or body hung ball bearing generators every six months. Stone Franklin generators are to be similarly opened up for cleaning of bearings every two years.

Bearings are to be thoroughly cleaned with kerosene and new Greeoil applied. Any other repairs to equipment that are found necessary are to be made. The generators are to be carefully inspected and any other repairs found necessary are to be made.

Record of overhauling is to be made on Periodical Inspection Report Tag Form 508-B-Spl., marking same thus, "Greased" in column marked "Oil or Grease," and reported on Form 504-Rev.-Spl., which is to be forwarded to Electric Car Lighting Supervisor, Baltimore, Md.

Regulating Apparatus: Examine moving parts and dash pots to see that they operate freely. On dash pots in which castor oil is used, see that same are filled to proper height and are in good

5m. 4-9-18. 21x32—35 Form 509-B—Spl.

THE BALTIMORE AND OHIO RAILROAD COMPANY
ELECTRICAL DEPARTMENT
MONTHLY REPORT OF CURRENT USED FOR CHARGING CAR LIGHTING BATTERIES

TERMINAL........................ MONTH OF.............................191..

DATE	CAR	Lighting System	TIME			VOLTS	AMPS.	AMP. HOURS	WATTMETER READINGS		K. W. HOURS	
			On	Off	Hours				Start	End	From Meter	
TOTAL AMOUNT CURRENT USED												

This Form Provides a Record for All Current Used for Charging Car Lighting Batteries at Terminal Points

working order. Examine carefully carbon pile rheostats, resistance tubes, etc., replacing any that are found defective. Clean all carbon discs and note that short-circuiting arm (if any) on lamp regulator makes good contact when arm is in position of minimum resistance. See that all parts are clean and that regulating apparatus and automatic switch are in proper adjustment.

Reports: Report of periodic inspection is to be made on Form 515-B-Rev.-Spl., as called for, and also to be noted on Periodic Inspection Report Tag Form 508-B-Spl. Any defects found or repairs made should be reported on Form 504-Rev.-Spl., along with last class "B" inspection date.

Batteries: The following periodic inspection of batteries in addition to class "A" inspections shall be made by electricians at intervals of 20 days. Examine battery connections, clean if corroded, making necessary repairs. Clean battery boxes, examine for defects, reporting to car foreman such repairs that should be made by his forces. Inspect battery fuses and if defective replace same.

THE BALTIMORE AND OHIO RAILROAD COMPANY
MONTHLY FAILURE REPORT
CHARGEABLE TO EACH TERMINAL
FOR MONTH OF JUNE 1924

STATION	POST MAIL & BAGG.	BAGG. & EXPR-ESS	COA-CHES	OFFI-CIAL	DIN-ING & CAFE	STOR-AGE	FAILURES EQUIP MENT	FAILURES LIGHT	DEPART-URES
NEW YORK		1	3				12	4	817
BALTIMORE		1					4	1	1930
WASHINGTON							2		2670
CUMBERLAND									601
PITTSBURGH			1		1		4	2	1652
CHICAGO	1		3				5	4	512
CINCINNATI	1						3	1	1291
ST. LOUIS							1		477
WHEELING									751
GRAFTON							2		492
PHILADELPHIA									
NEWARK									212
LOUISVILLE									164
ZANESVILLE									
CLEVELAND									236
UNKNOWN									
TOTAL	2	2	7		1		33	12	11805
TOTAL PER SYSTEM			12						11805

Monthly Summary Sheet Made Up From Forms 504 Rev. Spl. and 515 B Rev.—Spl. This Report Is Mimeographed and Sent to The Various Terminals. The Actual Size Is 8 In. by 11 In.

Edison batteries: If voltage tests show battery voltage less than 27.5 volts measure voltage of each cell, all lamps burning. If any cell is found to test lower than any other, mark the cell to identify it, and report same to Electric Car Lighting Supervisor on Form 504-Rev.-Spl., who will issue instructions for removal or repairs. Examine height of electrolyte and flush if necessary using distilled water only. Clean tops of cells thoroughly, using compressed air or steam jet, the latter where possible, also sides where in contact with crates, removing any deposits from electrolyte, and make sure that cells are free from grounds.

If water, potash or dirt is allowed to collect, the battery is apt to become grounded, causing electrolysis, which will destroy the cans. When formation of soda is found on vents, same are to be cleaned off thoroughly and oiled with special oil provided for this purpose.

Lead batteries: Individual cell voltage tests are to be made under the same conditions as for Edison batteries. In case low cells are found, remove, making necessary repairs if possible. Where unable to do so, replace with good cells, shipping defective cells to Storekeeper at Baileys, Baltimore, for repairs. Transfer to be reported on Form 504-A-Spl. Test specific gravity of electrolyte in each cell; if considerable variation is found charge battery completely; electrolyte should then be corrected where necessary, at the same time adjusting the proper level. Electrolyte should have gravity of 1.225 at temperature of 70 degrees F. Only water that has been approved by Test Department for battery use, or distilled water, should be used for flushing batteries.

Replace broken skids, buffers, vent plugs, covers or any other parts that are in defective condition. See that covers are properly sealed and vent plugs screwed securely to the covers. Clean battery thoroughly using compressed air or steam jet, the latter where possible.

Reports: Report of periodic inspection is to be made on Form 515-B-Rev.-Spl., as called for, and also to be noted on Periodic Inspection Report Tag Form 508-B-Spl. Record of flushing and height of solution in Edison batteries is also to be noted on this tag as follows:

When recording flushing of batteries, tag is to be marked in column under "Flushing," thus, "Flushed," which will mean that batteries have been flushed to the standard heights of two and three quarter inches (2¾″) above tops of plates for A-8-H and A-10-H Edison batteries, and three inches (3″) above tops of plates for A-4-H and A-6-H Edison batteries, and one inch (1″) above tops of plates for lead batteries. When class "B" inspection is made on batteries, and same do not require flushing, height of solution above tops of plates is to be marked on this tag in column under "Flushing," thus, 1¾," or whatever height same may be.

F-11

BALTIMORE & OHIO RAILROAD
ELECTRICAL DEPARTMENT

PERFORMANCE REPORT OF ELECTRIC LIGHTING OF PASSENGER CARS
FOR MONTH OF __________
DATE __________

SYSTEM OF LIGHTING

	STORAGE BATTERY L	STORAGE BATTERY A	AXLE GENERATOR CONSOLIDATED A L	CONSOLIDATED A A	CONSOLIDATED D-4 D-5 L	CONSOLIDATED D-4 D-5 A	E.S.B. E R L	E.S.B. E R A	GOULD B B L	GOULD B B A	GOULD G B L	GOULD G B A	SAFETY F L	SAFETY F A	SAFETY U-F L	SAFETY U-F A	SAFETY L	SAFETY A	STONE-FRANK. T-50 T-100 L	STONE-FRANK. T-50 T-100 A	U.S.L. O-3 L	U.S.L. O-3 A	TOTAL L	TOTAL A
GENERATOR																								
GEN. REGULATOR																								
LAMP REGULATOR																								
AMP HR METER																								
BELT																								
PULLEYS																								
BATTERY																								
FUSES																								
WIRING																								
UNKNOWN																								
TOTAL LIGHT																								
TOTAL APPAR.																								
NO. CARS																								

DISTRIBUTION OF FAILURES BY TERMINALS & CLASSES OF CARS

	STOR. BATTERY COACHES & BAGGAGE PART BAT. CARS L	PART BAT. CARS A	ALL BAT. CARS L	ALL BAT. CARS A	AXLE GENERATOR POSTAL MAIL & BAGGAGE L	POSTAL MAIL & BAGGAGE A	BAGGAGE & EXPRESS L	BAGGAGE & EXPRESS A	COACHES L	COACHES A	OFFICIAL L	OFFICIAL A	DINING & CAFE L	DINING & CAFE A	TOTAL L	TOTAL A	DEPARTURES	DEPARTURES PER FAILURE THIS YEAR	DEPARTURES PER FAILURE LAST YEAR
NEW YORK																			
PHILADELPHIA																			
BALTIMORE																			
WASHINGTON																			
CUMBERLAND																			
PITTSBURGH																			
GRAFTON																			
WHEELING																			
CLEVELAND																			
CHICAGO																			
NEWARK																			
CINCINNATI																			
LOUISVILLE																			
ST. LOUIS																			
TOTAL THIS YEAR																			
TOTAL LAST YEAR																			
NO. CARS EQUIP THIS YEAR																			
NO. CARS EQUIP LAST YEAR																			

	CARS OUT OF SHOP	REMARKS
MT CLARE		
LIMA		
WASHINGTON		

This Form Is Prepared Each Month in the Office of the Electric Car Lighting Supervisor and Forwarded to the Electrical Engineer As Soon After the First of the Month As Possible

Any defects found or repairs made, as well as gravity, height of solution on Edison batteries, and voltage reading taken, should be reported on Form 504-Rev.-Spl., along with date of last class "B" inspection.

Class "C" Inspection—Inspection of Passing Electrically Lighted Cars at Division Points

The following inspection shall be made at such division points as instructed of electric lighting equipment on passing cars.

Suspension, etc.: At all division points where regular car inspections are made, electricians as well as car inspectors, shall

inspect axle generators and suspension to insure they are safe and examine battery boxes for loose or missing door fasteners.

Belts: At such division points as instructed, electricians shall inspect axle generator belts on all cars, replacing those missing. Where applied to Pullman or foreign cars the company affected shall be billed for same.

Inside inspection: (Only cars electrically lighted by the railroad). Turn on all lamps to ascertain if burning at proper brilliancy and to locate burned out lamps or lamp circuit fuses, which should be replaced. If lights are dim every effort should be made to remedy trouble, if time permits. If trouble cannot be overcome, car should be trainlined to adjoining car, if electrically lighted at same voltage.

Report on Form 504-Rev.-Spl., any trouble found, sending original in electric locker of car to next terminal, and copy to Electric Car Lighting Supervisor, Baltimore, Md.

It can be readily appreciated that with these instructions carried out by the several terminals, there will result a definite uniform system of maintenance and inspection which will be reflected in the excellent condition of the equipment. The knowledge that these instructions are uniform at all terminals of the Baltimore & Ohio is one of the strongest factors in securing close adherence to them.

From the performance reports which are sent in from the various divisions, summary reports are compiled in the office of the supervisor of car lighting and sent to the master mechanics of the several divisions of the road so that each division may have the opportunity to see how it stands with respect to the others as regards failures of the car lighting equipment.

The first of these reports is made out weekly and gives detail information relative to each lighting or equipment failure, also showing the terminal from which the car departed as well as the terminal making the inspection. In addition the report shows the belt applications and generator greasings for the week.

The second report is known as a monthly failure report and shows the failures which are chargeable to each terminal during the month. A typical example of this report is shown on page 37.

Copies of this report are also sent to the various terminals of the road.

Electrification Progress on the Illinois Central

FROM present indications the electrification of the Illinois Central Chicago terminal will progress materially during 1925. As noted in the *Railway Electrical Engineer* of December, 1924, this road has entered into a contract with the Commonwealth Edison Company of Chicago whereby the latter will furnish the electric power for the operation of the electrified portion of the Illinois Central within the Chicago terminal district. The power company is at present engaged in the design of sub-stations to be erected along the right-of-way. Bids for the construction of the sub-stations and for the furnishing of the electrical equipment required will be asked within the next two or three months. The construction of roadway equipment will be well under way by the end of 1925. Some of the foundations for the steel bridges are already in and the remainder will be installed during this year. Steel bridges will be erected starting early in the spring followed immediately by the stringing of overhead wires. Orders amounting to $8,250,000 for 130 suburban coaches and 85 trailers, as well as for the electrical control equipment, were placed in November, 1924.

Power Requirements

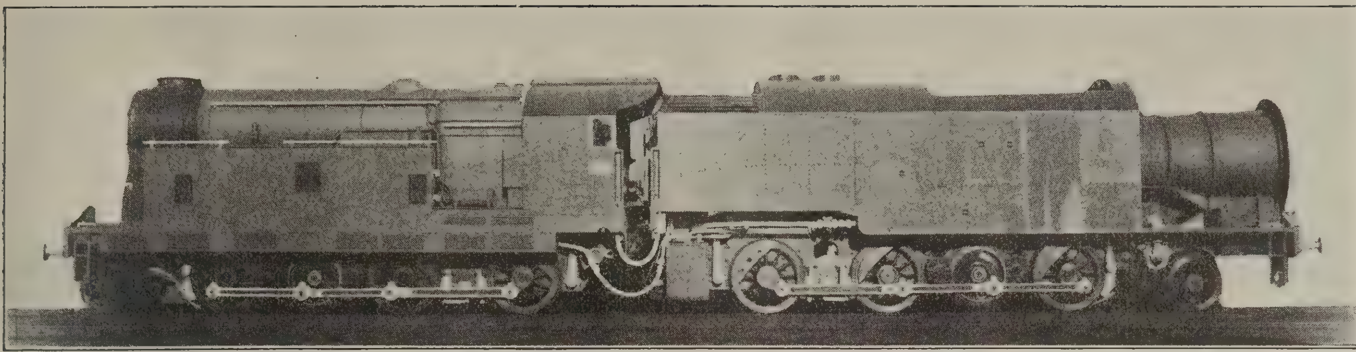
Under the terms of the contract ordinance between the railroad company and the city of Chicago, it is planned that electrified freight service north of Roosevelt road will be completed by 1930. This ordinance also provides for the electrification of freight service south of Roosevelt road by 1935, and for complete electrification of both freight and passenger services by 1940, provided that 80 per cent of the roads then using the Illinois Central passenger terminal are equipped for electrical operation. The power needed for electrification is provided for under a 10-year agreement entered into with the Commonwealth Edison Company, and includes a clause providing for optional extension to 1947. Under the terms of this contract the public utility company is to have power available by the summer of 1926, which will be from 22,000 to 25,000 k.w., depending upon the volume of suburban traffic at that time. Sufficient power facilities to handle the entire suburban traffic must be available early in 1927. The public utility also agrees to furnish approximately 45,000 k.w. by 1940, when it is planned that the entire electrification project will be completed. This includes in addition to the power requirements of electric traction, the power necessary for the operation of the alternating current signaling system and the electrical energy necessary for lighting all of the stations and other facilities. The power requirements for lighting and switching at the new Markham Yard are also provided for in this agreement. Provision is made for furnishing the electrical power for the operation of the Burnside shops, but the I. C. reserves the option to continue the operation of the present steam plant.

Seven sub-stations will be erected along the right-of-way between the new Roosevelt road terminal and Matteson, Ill., for converting the 12,000 volt a.c. energy furnished by the power company's underground transmission lines in the city and the 33,000 volt a.c. overhead lines outside the city, to 1,500 volt d.c. energy for the operation of the multiple unit trains and locomotives. Sites have been secured for four of the seven sub-stations to be built. These four plants are to be located as follows: 18th street and Indiana avenue, 69th street and Kenwood avenue, 80th street and the Illinois Central and 123d and Laflin streets. Sub-station locations for the Kensington, Harvey and Vollmer Road installations are yet to be purchased. Rotary converting equipment will most likely be installed, but this has not been decided definitely as yet.

The present signal bridges now in service will be adapted to fit into the electrification program between Homewood, Ill., and Richton. New combined signal and catenary structures will be provided elsewhere.

According to the biennial census of manufactures, 1923, the total output of electrical machinery, apparatus, and supplies in the United States during that year was valued at $1,304,650,999, as compared with $818,415,159 in 1921, the last preceding census year.

Of the total for 1923, $184,510,010 was contributed by insulated wire and cable, $127,212,066 by motors and parts, $124,630,467 by batteries, $90,857,998 by telephone apparatus, $71,967,458 by incandescent lamps, and $67,-002,084 by household apparatus.



Side View of the Ramsay Turbo-electric Locomotive

Turbo-Electric Condensing Locomotive*

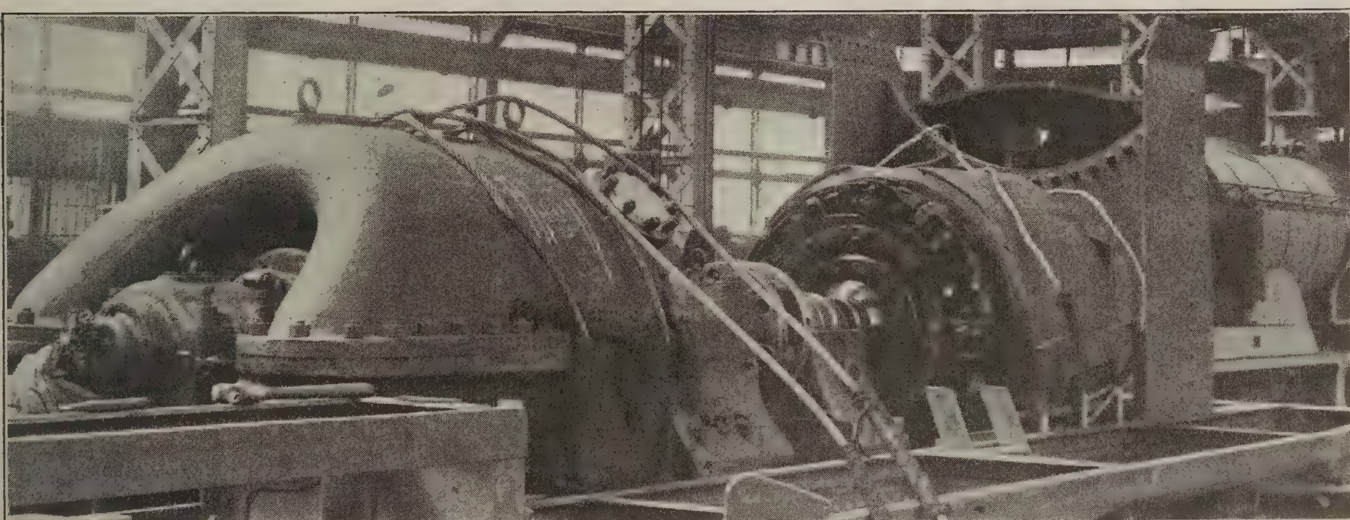
Steam Turbine Drives A. C. Generator and Motors Are Connected to Driving Wheels By Gears and Side Rods

WITH the present-day demands for increased hauling capacity together with greater need for economy in fuel consumption, emphasizing, in these respects, the limitations of the orthodox designs of locomotives, it is not surprising to find engineers contemplating the attractive possibilities offered by locomotive development along lines other than the conventional.

It is apparent that there is great room for improvement when it is considered that a locomotive of the ordinary type has a thermal efficiency of only approximately six per cent and that doubling its thermal efficiency would reduce the fuel consumption by half or, alternatively, allow a much more powerful engine to be built with the present practical limits of firebox area.

The replacing of cylinders by the steam turbine is an innovation in locomotive construction, but not more so than the application of condensation which is rendered possible by its introduction. From a thermodynamic point of view, it is evident that turbo locomotives, whatever their systems of power transmission, whether electrical or gear, largely depend for their economies in fuel consumption upon the efficiency and reliability of their condensing plant.

It is to be understood that the Ramsay locomotive is regarded as experimental, designed and constructed for the purpose of obtaining technical data and demonstrating the capabilities of the type. It conforms to British standard practice as regards the restrictions imposed by the load line gage, etc., although, naturally, in view of the radical departure in design, it has been confined mainly to test and demonstration running, rather than everyday service. It may be mentioned that compact and uniform designs were disregarded in the interests of experiment, the motor driven auxiliaries, in every case, having been purposely kept separate and ungrouped from the main power plant in order readily to obtain their particular power consumptions. In addition, many power registering devices, gages and instruments have been fitted, greatly in excess of those necessary to the ordinary equipment, all of which tend to give the locomotive,



Turbo-Generator Unit on Locomotive Frame During Assembly

*Abstract of a paper by George F. Jones and T. Laurence Hale presented before the annual meeting of the Railroad Division of the American Society of Mechanical Engineers.

especially the cab, an intricate and complicated appearance.

General Description

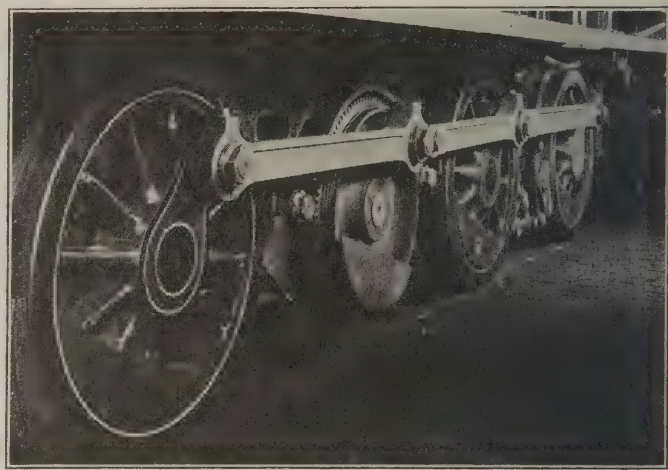
The locomotive consists of two portions, the front and rear, connected by a special form of universal joint. The front portion incorporates the boiler, forced draft set and driver's cab, the main turbo-alternator set and the auxiliary direct-current turbo generator being situated under the boiler. The rear portion of the locomotive is practically devoted to the condensing plant with axial fan, condensate extracting pump, etc. Room, however, has been found for the main water tank and coal bunker. Communication between the turbines and condenser is by way of the 24-in. diameter exhaust pipe, which is provided with a flexible rubber connection reinforced by internal rings of aluminum.

Each portion of the locomotive carries two driving motors, each pair of motors being bolted to a center cross-bearer which carries a transmitting shaft and spur wheels. Pinions are keyed to the motor shafts and these mesh with the spur wheels, the power being finally transmitted through coupling rods from the spur wheels to the driving wheels in the ordinary manner. One of the illustrations shows the spur wheel and pinion shafts, the pinions having been removed. Both are enclosed in a gear case and run in an oil bath. The gear ratio is 2.8 to 1.

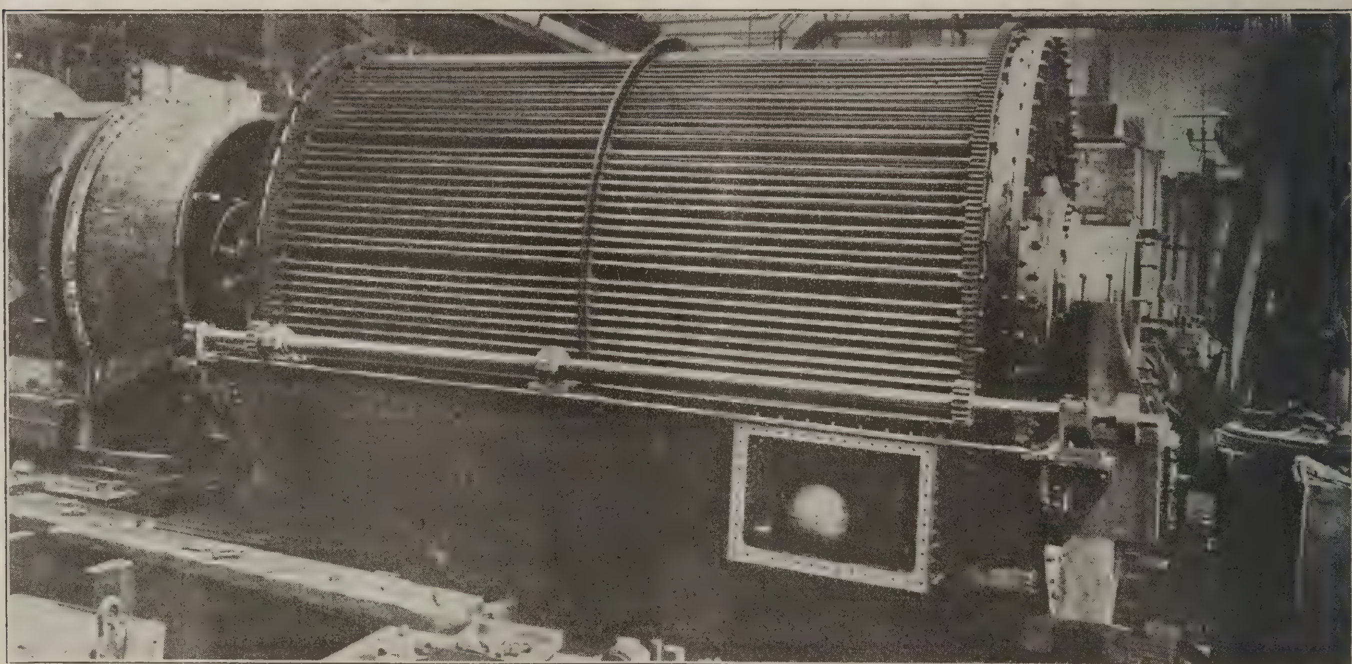
The main turbine is of the impulse type and contains nine stages. The mean blade diameter is 36 in. It is designed for a steam pressure of 200 lb. per sq. in., and the steam is superheated to a total temperature of 685 deg. F., exhausting to a vacuum of 27 in. The turbine is flexibly coupled to a three-phase alternator and has a speed range of 1,800 r.p.m. at starting to 3,600 r.p.m. at 60 m.p.h. The three-phase alternator is designed to develop 890 kw. at a maximum pressure of 600 volts.

The auxiliary turbine is a single stage machine flexibly coupled to a direct-current generator, which provides the energy for the excitation of the main alternator poles as well as for the auxiliary direct current motors driving the condenser fan, condenser rotor, condenser extracting pump and the forced draft set for the boiler. It also supplies the necessary current for lighting the train. The auxiliary turbine operates under the same steam conditions as apply to the main turbo set.

The boiler is of the ordinary locomotive type and the combustion chamber is supplied with air by a high speed forced draft set situated on the locomotive cab. A simple locking device is provided on the furnace door to prevent a blow-back, the door being prevented from opening by a safety catch when the forced draft fan is in operation.



Power Is Transmitted to the Driving Wheels by a Spur Pinion and Wheel Which Are Enclosed, and Run in an Oil Bath



General View of the Condenser with Its Casing Removed

The transmission of power from the main turbine to the driving motors is three-phase, current being supplied from the alternator to the four alternating current slip ring motors, each motor having a continuous output capacity of 275 b.hp. and one hour's rating of 360 b.hp.

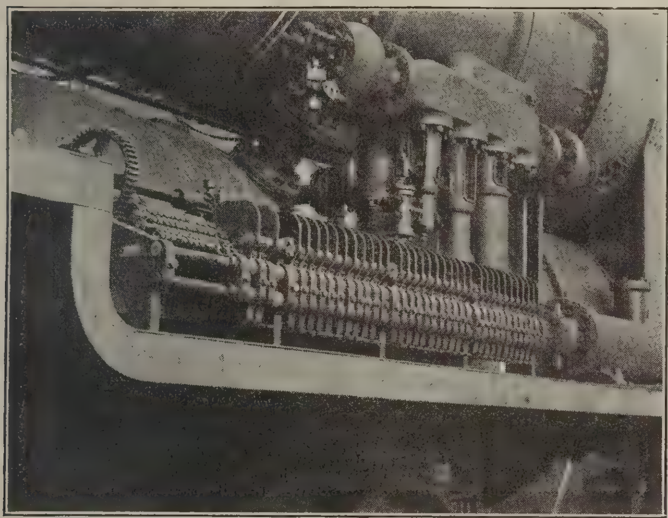
The following are the tractive forces at the rims of

the driving wheels for the acceleration period from rest to 60 miles per hour:

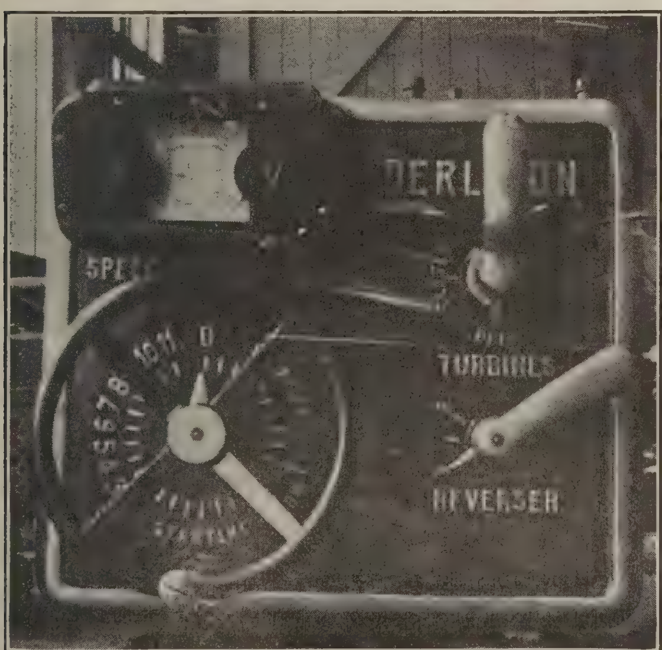
Miles per hour	Tractive force
Starting	22,000 lb.
15	22,000 lb.
30	11,050 lb.
60	8,600 lb.
Normal running, 60 miles per hour	6,000 lb.

Design and Description of the Condensing Plant

As the success of a locomotive of this description depends in such a large measure upon the design and action of its condenser, it is perhaps not irrelevant to give a very brief review of the groundwork which influenced the adoption of the principle of evaporation as the basis of design for the present condenser.



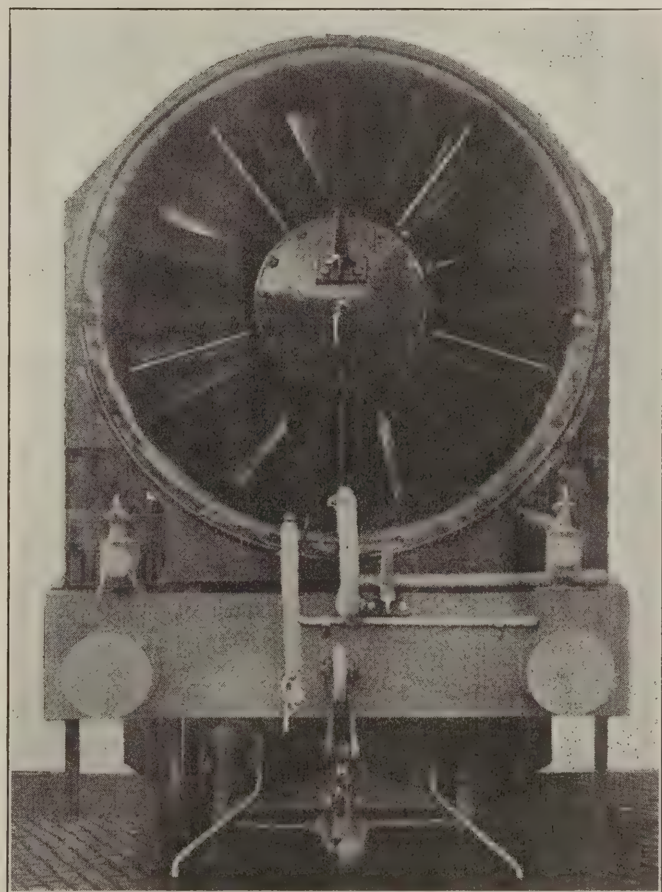
Covers Removed on Right Side to Show the Grid Resistances and Turbine Governor



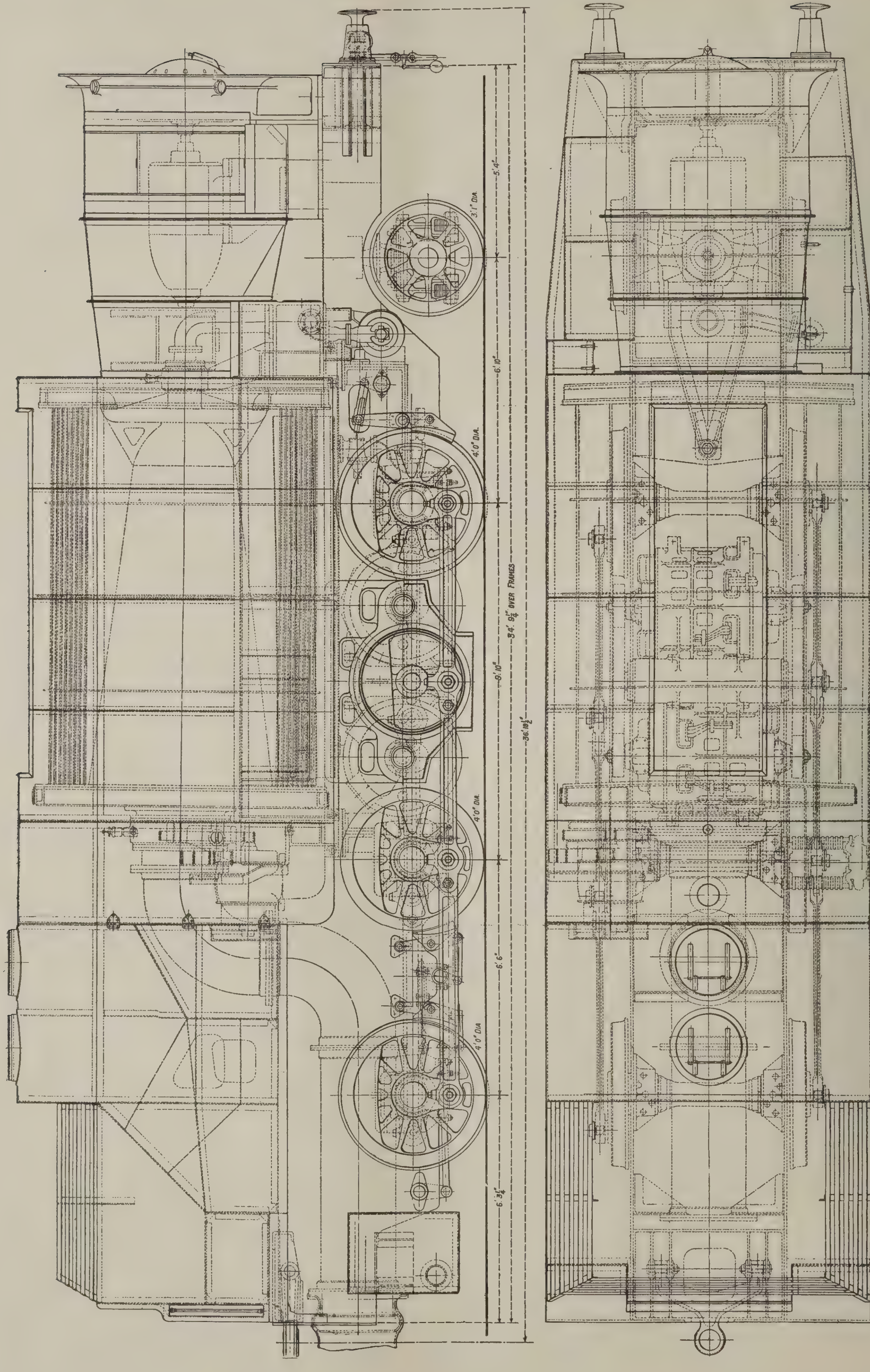
The Entire Control of the Locomotive Is Centered at this Master Controller

In the light of previous experience of the difficulties of recooling condensing systems, it was decided to attack the exhaust steam by direct means. It was fully realized that the alternative method to evaporation, that of direct cooling by air alone, involved employment of large condensing surfaces and excessive fan power, and that such a type of condenser would depend for its success largely on atmospheric conditions, and, while probably producing a satisfactory vacuum in low temperature countries, the system would be at a great disadvantage and far from satisfactory in hotter climates. Attention was, therefore, turned towards evolving a suitable condenser on the direct cooling system based on the evaporative principle as being the system to successfully meet the atmospheric conditions of all countries.

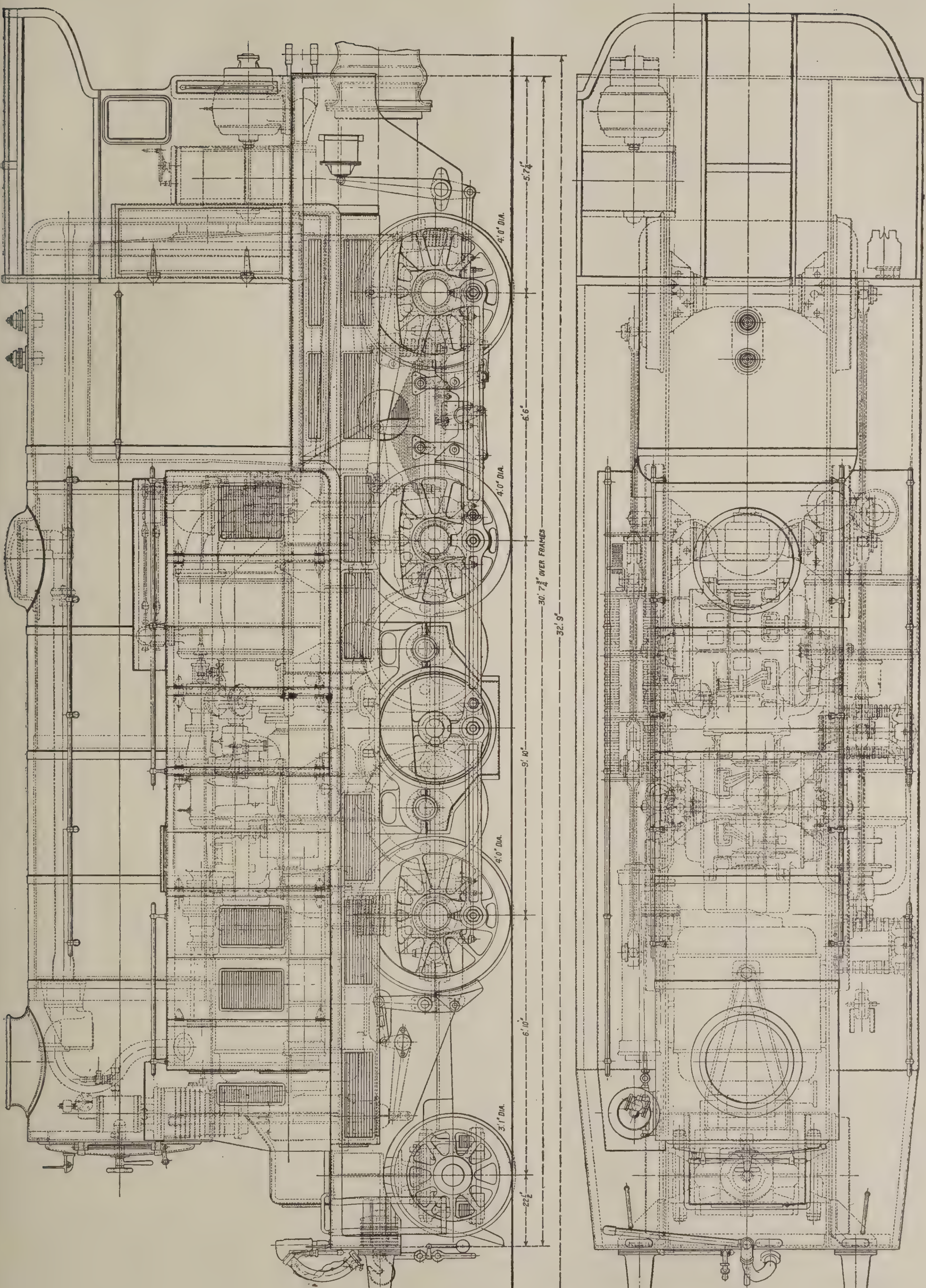
In design, the ordinary evaporative condenser has progressed but little and still remains practically as originally conceived; such test results as existed were unreliable and it was, therefore, necessary to carry out a series of preliminary experiments on small scale condensing apparatus with fans to produce a current of air and so intensify the evaporative effect. The importance of maintaining a thin and unbroken water film upon the condensing surfaces was easily demonstrated and, of the numerous methods and contrivances tested with a view to producing satisfactory water filming of the surfaces under a blast of air, the simple method of completely immersing the surfaces in water before exposing them to the air current was found to give the most reliable and proper film effect. Repeated tests on a small condensing plant proved the type to be exceedingly economical in water consumption, in practice only approximately one pound of water being evaporated to condense one pound of steam. The fan power required was reasonably low while the rate of heat transmission was found to be moderately high and suf-



Rear View of the Locomotive Showing the Condenser Fan



Elevation and Plan of the Tender and Condenser Section



Elevation and Plan of the Forward Section of the Ramsay Turbo-Electric Locomotive

ficient to bring the condensing surface well within the practical limits.

Further experiments were carried out on a plant containing some 400 sq. ft. of surface. For the sake of simplicity, the condensing surfaces were composed of ordinary brass condenser tubes and, as a natural development to facilitate the process of filming, they were arranged in the form of a hollow cage, or hollow drum. The drum, supported between bearings, was rotated in a tank containing water, the tubes passing through the water as they rotated.

The condenser was supplied with air by an axial fan and was tested in conjunction with a steam regenerator and the necessary wet air pump, water filming of the surfaces and resultant evaporation taking place successfully. The promising results from this experimental work led to the design and construction of the present locomotive condenser.

Reference to the drawing shows the general arrangement of the rear portion of the locomotive. Ordinary condenser practice was observed in the construction of the drum, which consists of an annular nest of standard ¾-in. brass condenser tubes ferruled into two headers. The exhaust steam entering one header is condensed, and the resultant condensate is collected and drawn off from the other header and returned to the hot well by the rotary extraction pump as hot and clean feed for the boiler. The trunnions of the respective headers are fitted with air-tight glands of the steam sealed self-adjusting type. This design of gland has given every satisfaction in resisting air leakage into the condenser.

As will be seen, a small motor, driving through a spur gear, turns the drum which is housed in a sheet metal casing, the bottom of which forms a tank containing the water for purposes of filming which is fed from the main tank. A pneumatic float maintains the water at a constant level.

The condensate extracting pump is of the ordinary rotary condenser design, while the air pump is of the steam ejector type and has two stages; it is supplied with steam from the boiler through a reducing valve.

Before being erected on the locomotive, the complete condensing plant was fully tested in conjunction with a 1,500-hp. triple expansion engine and satisfactory results were obtained.

Control of Power and Speed Regulation

As will be seen, the starting torque of the motors is about three times that of the normal and is obtained as follows: Before starting the locomotive, the auxiliary turbine is run up to speed, 3,000 r.p.m., thus providing excitation for the main alternator and energy for the motor-driven auxiliaries. The main turbine set is then run up to half speed; viz., 1,800 r.p.m. At this period the motors are connected in cascade by the master controller in the driver's cab. It is then that the locomotive may be started.

It is well known that when a turbine speeds up from rest to full speed, its torque decreases in the ratio of 2 to 1, and when passing through the period of half speed its torque is one and one-half times the normal. This is the torque of the main locomotive turbine when running at starting speed; namely, 1,800 r.p.m. Again, two alternating current motors when connected in cascade and running at half the alternator speed have twice the turning moment that they have when connected in parallel with the same power consumption. Therefore, with the driving motors in cascade and the main turbine running at half speed, the torque from rest to quarter speed will be two times 1.5, or three times the normal torque. The motors now being connected in parallel, the turbine still running at half speed, the speed of the locomotive increases from one-quarter to one-half speed and the torque is then 1.5 times the normal. The turbine speed is then increased to the maximum and the torque drops from 1.5 times the normal to normal.

In controlling the speed of the Ramsay locomotive from rest to 60 m.p.h., the following sequence of operations is observed: After the main and auxiliary turbines have been brought to speed by means of the hand wheels in the cab which control the steam inlets, all control of the locomotive is carried out electrically by means of the master controller in the cab. To start the locomotive, the controller wheel is moved to the first notch, thereby closing the excitation circuit of the alternator and connecting the driving motors in cascade with resistance wholly in circuit. Further movement of the control wheel cuts out resistance until a first running position of 15 m.p.h. is obtained. If a greater speed is desired, the controller wheel is moved further, which changes the motor connections from cascade to parallel. The excitation circuit being again closed, the motors once more operate under current, resistance being cut out until a second free running speed of 30 m.p.h. is reached.

Further increases of speed are obtained by further moving the controller wheel around, step by step, whereby the setting of the main turbine governor is correspondingly altered, that is, the speed of the turbo-alternator is increased and thereby the periodicity. In this manner the speed of the locomotive can be increased from 30 to 60 m.p.h. A reduction in the speed of the locomotive is obtained by turning the controller wheel quickly back to the zero position, thus observing the reverse succession of operations to those of starting up to full speed. The excitation circuit being opened, the motors are without current and ready for starting up again in cascade.

Reversing the locomotive is, of course, effected by reversing the driving motors in the ordinary way. The general arrangement of the front portion of the locomotive is illustrated, showing the resistances, which are of the grid type, arranged under the running plates on either side. Both vacuum and Westinghouse brakes are fitted.

Principal Dimensions and Proportions

Length overall	69 ft. 7 in.
Length wheel base, total	59 ft. 4 in.
Length, rigid wheelbase	16 ft. 4 in.
Driving wheel diameter	4 ft. 0 in.
Height from rails to center line of boiler	10 ft. 3 in.
Maximum width	9 ft. 0 in.
Total heating surface of boiler	1,543 sq. ft.
Grate area	28 sq. ft.
Tractive force at starting	22,000 lb.

Shop and Main Line Testing

The trials to which the Ramsay locomotive has been subjected have extended in one form or another over a prolonged period and often under adverse atmospheric conditions.

Shop tests, to ascertain the reliability of the special electrical control, were carried out before the locomotive proceeded to the Horwich works of the London, Midland & Scottish for actual running trials. By disconnecting the terminals of the alternator and connecting it to water

resistance, it was possible to make many tests which did not justify a main line trial and afforded convenient means of obtaining readings on the condenser which would otherwise have been difficult to procure with the locomotive in motion. Numerous tests were made under these conditions and a large amount of technical data collected.

In addition, several main line trials have been accomplished, and on these occasions the locomotive hauled heavy trains without difficulty, a vacuum ranging from 80 to 95 per cent being regularly attained and held. Smoothness of running was pronounced, due to the constant and even turning moment exerted by the driving motors.

At no time during the run did the temperature of the condenser exceed 135 deg. F., which corresponds to a vacuum of 25 in. of mercury. The work of running and firing was carried out by ordinary railway employees and, as all the work in speeding up the locomotive is performed electrically, the duties of the engineman, so far as controlling the locomotive is concerned, are confined to the turning of the controller wheel, the operations of which have already been described, while the duties of the fireman are not as onerous as those connected with the ordinary locomotive.

In considering the efficiency of the condensing plant, some regard must be paid to the amount of power consumed in its operation, and, as in this case, the major portion of the cooling is due to evaporation, the power absorbed by the fan is proportionately low. The average power consumption of the three-condenser auxiliary motors ranges between 25 b.hp. at low loads to 40 b.hp. at high loads. The heat from the air ejector steam exhaust was recovered in the hot well.

No difficulties were experienced on account of deposits of scale and, although the filming water was far from pure, the slight scale which formed on the tubes assisted rather than impeded the water filming. Inspection of the inside of the tubes and headers showed them to be clean and free from deposit or corrosion after some months running.

The foregoing is but a brief description of a locomotive which has proved beyond doubt that the application of the turbine and condenser to locomotive use is rational and reliable. The transmission of energy from turbine to locomotive wheels may be either carried out by mechanical gears interposed between the turbine and wheels, or electrical means may be employed. For moderate powers, there is much to be said in favor of the former, but for large powers the balance of the advantages lies with the latter means.

The exhaustive tests taken over a long period have demonstrated conclusively that there is now little difficulty in providing condensing apparatus which will maintain the requisite economical vacuum when dealing with the heaviest traffic.

Exports of all classes of electrical equipment for the year 1924 will approximate $85,000,000, and will exceed the 1923 total by about $12,000,000, according to the electrical equipment division of the department of commerce. This estimate is based on trade figures for the first eleven months of the year and does not include figures covering exportation of such electrical equipment as motor cars, the built-in motors of machine tools, etc.

Some Commutation Troubles and How to Correct Them*

This article, which is the fifth of a series of brush articles and really a continuation of article No. 4†, contains an outline of some of the troubles encountered with commutating machines, together with their causes and remedies. Article No. 4, entitled "Some Causes of Sparking," contains 22 remedies for sparking. Some of the remedies recommended here are identical with those in article No. 4, so that it is necessary to refer to No. 4 in order to use the following outline to the best advantage.

Flat Spots

1. Any form of sparking.—See No. 4†.
2. High bar.—Tighten the commutator bolts and turn or grind the commutator.
3. Low bar.—Use commutator stone or turn or grind the commutator.
4. Eccentric commutator on high-speed machine causing the brush to jump from the commutator at the high spots.—Turn or grind the commutator.
5. Surges of load current due to short circuit on the line or an instantaneous high peak load.
6. Mechanically unbalanced armature—Place on balancing ways and add weight at lightest point.
7. Difference in hardness of commutator bars.—Undercut the mica and use non-abrasive brushes.
8. Difference in hardness of mica.—Undercut the mica and use non-abrasive brushes.

Black Commutator

1. Sparking.—See No. 4†.
2. Too much lubricant.—Clean commutator with gasoline.

Heating

1. Severe sparking.—See No. 4†.
2. Short circuit current.
   - 2a. Brushes off neutral.
   - 2b. Faulty brush spacing.
   - 2c. Too thick brushes.
   - 2d. Unequal air gaps.
   - 2e. Crooked brush studs.
   - 2f. Too low contact of brushes.
   - 2g. Unbalanced armature winding.

   For remedies see No. 4†.
3. Too high or too low brush pressure.—Pressure should be 1¾ to 2¼ pounds per square inch cross-section for stationary motors and generators, 2½ to 4 pounds for elevator and mill motors, 3 to 5 pounds for crane motors, and 4 to 7 pounds for railway motors.
4. High-friction brushes.—Undercut mica and use low-friction brushes.
5. Commutator too small.—Consult the manufacturer of the machine.
6. Too high a ratio of brush area to commutator surface.—Use fewer brushes of higher carrying capacity and lower friction.
7. Overloads.—Undercut the mica, use low-friction brushes and check up all causes for short circuit current to reduce temperatures as much as possible.
8. Chattering of brushes.—See general heading "Noise."

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*Bulletin published by the National Carbon Co., Inc.

Pitting or Honey-Combing of Brush Faces

1. Short-circuit currents.—See paragraph 2 under the heading "Heating."

2. Too low brush pressure.—See paragraph 3 under general heading "Heating."

3. Brushes of insufficient carrying capacity.—Consult a brush manufacturer.

Picking Up Copper

1. Heavy short-circuit currents.—See paragraph 2 under general heading "Heating."

2. Sand under the brush faces.—Wipe brush face carefully after sandpapering either brushes or commutator.

3. Commutator not thoroughly cleaned after turning.—Finish the surface with a commutator stone after turning.

4. Collection of copper dust by lubricant in abrasive brushes.—Undercut the mica and use non-abrasive brushes.

5. Electrolytic action.—Change the grade of brush; better consult a brush manufacturer.

Noise Due to Chattering

1. High-friction brushes.—Change the grade of pressure.

2. Rough commutator.—Use a commutator stone.

3. Dirty commutator.—Clean with gasoline.

4. High mica.—Use a commutator stone or undercut the mica.

5. Wide slots with thin brushes.—Fill the slots with commutator cement.

6. High bars.—Tighten the commutator bolts and turn or grind the commutator.

7. Flat spots.—Use commutator stone unless the flat spots are too large for stoning, in which case turn or grind the commutator.

8. Brush operating at wrong bevel, frequently found where brushes are operating in a stubbing position with angles of less than 20 degrees.—Change the grade of brush or angle of operation. Better consult a brush manufacturer or the manufacturer of the machine.

Loosening of Shunts

1. Poor workmanship in attaching shunts.

2. Insufficient carrying capacity.—Consult a brush manufacturer.

3. Heating.—See general heading "Heating."

4. Vibration.—See general heading "Noise."

5. Combination of heating and vibration.

6. Loose terminal screws causing unequal distribution of load.

7. Unequal brush pressure causing unequal distribution of load.—See that all brushes are uniform and conform to recommendations given in paragraph 6, under general head of "Sparking."†

8. Heavy short-circuit currents between different brushes.—See sub-divisions 2b, 2d, 2e and 2g under general heading "Heating."

†"Some Causes of Sparking," *Railway Electrical Engineer*, Sept., 1924, p. 284.

Elementary Theory of Alternating Currents

A Series of Practical Articles Explaining a Difficult Subject in a Simple Manner

By K. C. Graham

Part IX. Induction Motors

In common with most other alternating current machinery, induction motors are made in single-phase and in polyphase types. But for reasons that will become more apparent later on we shall reverse the order of treatment of this subject in that we shall study the polyphase motor before taking up the study of the single-phase machine.

This type of motor resembles the alternator or the synchronous motor in that it has a stationary part, called the stator, and a rotating part called the rotor. The stator contains windings similar to those used in the case of the generator and the synchronous motor; in fact, the stator of an induction motor could be used as that of a generator if occasion demanded.

The rotor of the induction motor is, however, unlike that of the alternator or the synchronous motor insofar as its construction is concerned. These rotors may be divided into two general types, the squirrel cage type and wound type. The more common type, perhaps, is the squirrel cage; the wound rotor type being used for special conditions. The principle of operation, however, is exactly the same, but for purposes of illustration we shall first investigate the squirrel cage type. Before taking up the study of the principles involved we shall get a clear mental picture of this type of winding by referring to Fig. 81.

Fig. 81 (a) shows a squirrel cage, so called because of its shape, made up of copper bars *c* fastened to end rings *R* which are also usually made of copper. Fig. 81 (b) shows this squirrel cage mounted on the rotor core. The rotor core is made up of thin iron sheets called laminations, having slots *P*, Fig. 81 (c) cut in their periphery. Several of these laminations are mounted on the rotor shaft *s*, Fig. 81 (b); the copper bars are then placed in the slots and the end rings screwed, brazed or welded to the bars. It might be mentioned, in passing that all iron parts of the magnetic circuit of alternating current machines are made up of laminated iron. This is done in order to reduce the losses resulting from eddy currents. Each lamination is painted with an insulating varnish and baked dry; then when they are assembled they offer a high resistance to the formation of eddy currents which tend to flow across the core.

There is no electrical connection between the stator and

the rotor, in fact, in the case of the squirrel cage rotor there is no connection between the rotor and any other apparatus. In any case there is no current supplied to the rotor from any source other than itself. One might wonder how, then, any work was performed by the ma-

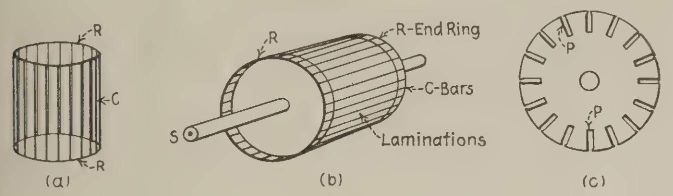


Fig. 81

chine. It shall now be our purpose to discover the theory under which operation of the motor is possible.

This type of motor operates by virtue of currents that are generated in the rotor by means of electrical induction. Fig. 82 will serve to make this more clear. *W* represents a small section of the rotor, the bars being denoted by the letter *c* and the end rings by the letter *R*. The conductors of one of the stator poles are also shown at *a* and *b*. The stator magnetism revolves, as mentioned in regard to the synchronous motor, at a speed corresponding to the synchronous machine of that number of poles; thus a four-pole 60 cycle-machine has a synchronous speed of 1,800 revolutions per minute (r.p.m.), so that if this machine were a four-pole 60-cycle one its magnetic field or stator magnetism would revolve at the rate of 1,800 r.p.m. It

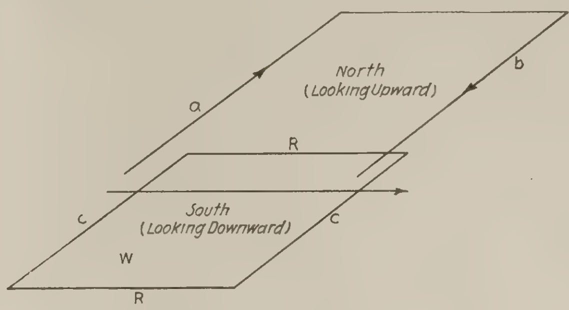


Fig. 82

is necessary to the operation of the motor that the rotor run at a somewhat slower speed than this. The reason will become apparent shortly.

In the average motor of this specification the rotor will revolve about 1,750 revolutions per minute, this being 50 revolutions less than the stator magnetically revolves.

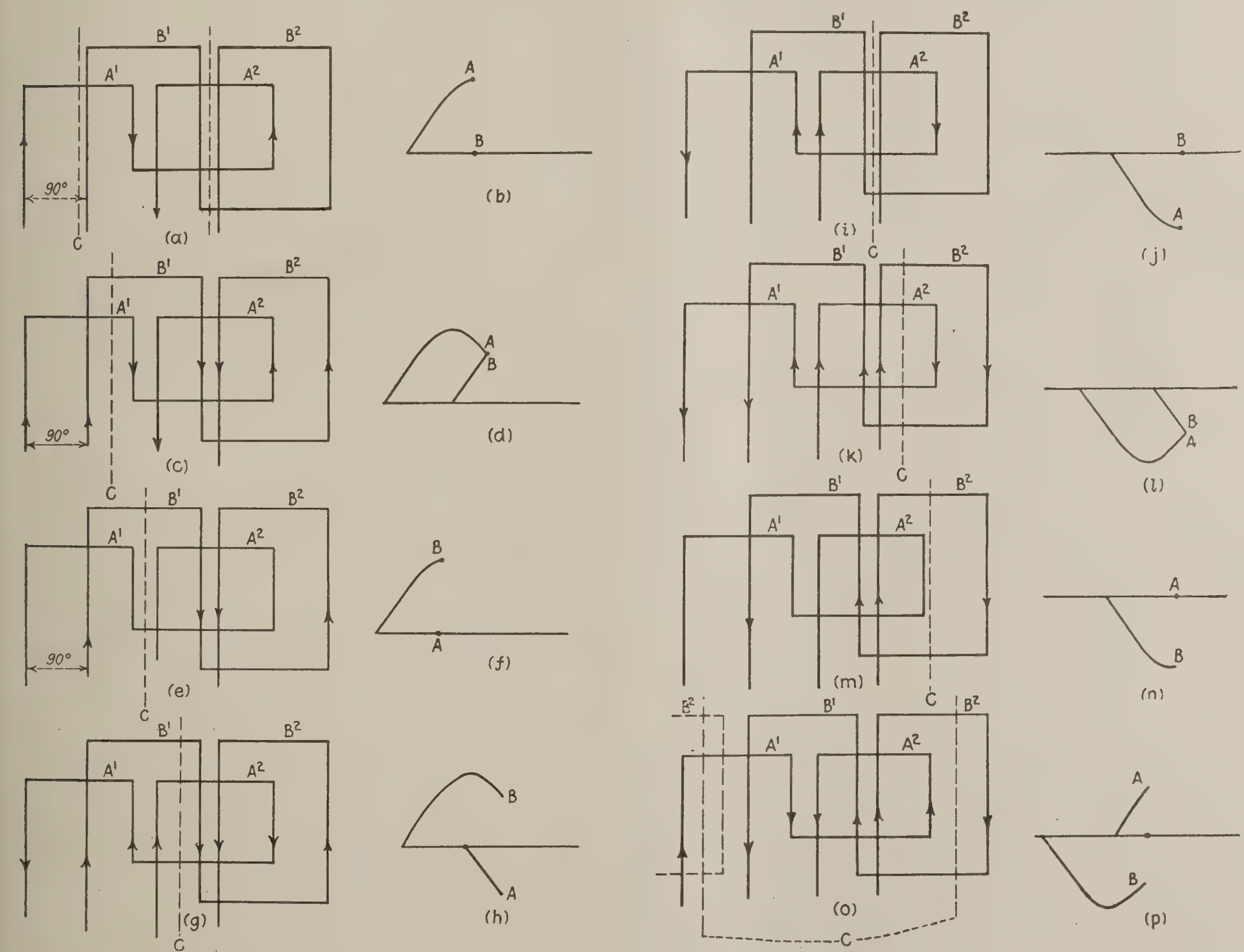


Fig. 83

This difference of 50 revolutions between the two is called the *slip* of the motor. If the rotor revolved at the same speed as the stator magnetism it would not cut any of the magnetic lines and, therefore, no voltage would be gen-

erated in it. However, we have just noted that the rotor revolves 50 revolutions slower than the stator which is equivalent to its cutting across the stator magnet flux at the rate of 50 r.p.m. As *W,* Fig. 82, slips backward it cuts across the stator flux and a current is induced in it as shown, the resultant polarity being, in this case, a south pole. Imagining oneself as viewing the stator pole from the under side, its polarity, is seen to be north, so that there will be an attraction between it and the rotor pole. As will be shown in the next paragraph, the stator poles *gradually* revolve, dragging the rotor around with them.

Fig. 83 illustrates a complete magnetic revolution as applied to the stator of a two-phase motor. *A* and *B* represent the conductors of a two-pole machine, these sets of conductors being spaced 90 degrees apart as shown. In Fig. 83 (a) the current in phase *A* is a maximum, while that in phase *B* is zero, so that the center of the resultant pole will be at the center of coil *A* as shown by the dotted line *C*. One-eighth of a cycle later the current in phase *A* will have dropped to a point about half way between maximum and zero, while that of phase *B* will have risen to about the same point, Fig. 83 (d). Then, as they will be equally effective in causing the resultant polarity, the center of the resultant pole will be as indicated by the line *C*. Another eighth cycle finds the current in *A* zero while that in *B* is a maximum, Fig. 83 (f), so that the center of the resultant pole is at the center of *B,* as shown in Fig. 83 (e). An eighth cycle later, Fig. 83 (h) the current in *B* will have fallen to the midway point, while that of *A* will have reversed and will be of equal strength, the position of the resultant pole being as shown in Fig. 83 (g). It might be supposed, at first thought, that the polarity of the moving pole would be changed due to the fact that the current in *A* will have reversed, but it will be seen that this reasoning is faulty when we note that the second coil of phase *A* (*A2*) is wound in the opposite direction from that of the first coil (*A1*). This method of winding the coils is the same as noted in connection with the other pieces of apparatus that we have studied thus far; that is successive poles alternate in polarity.

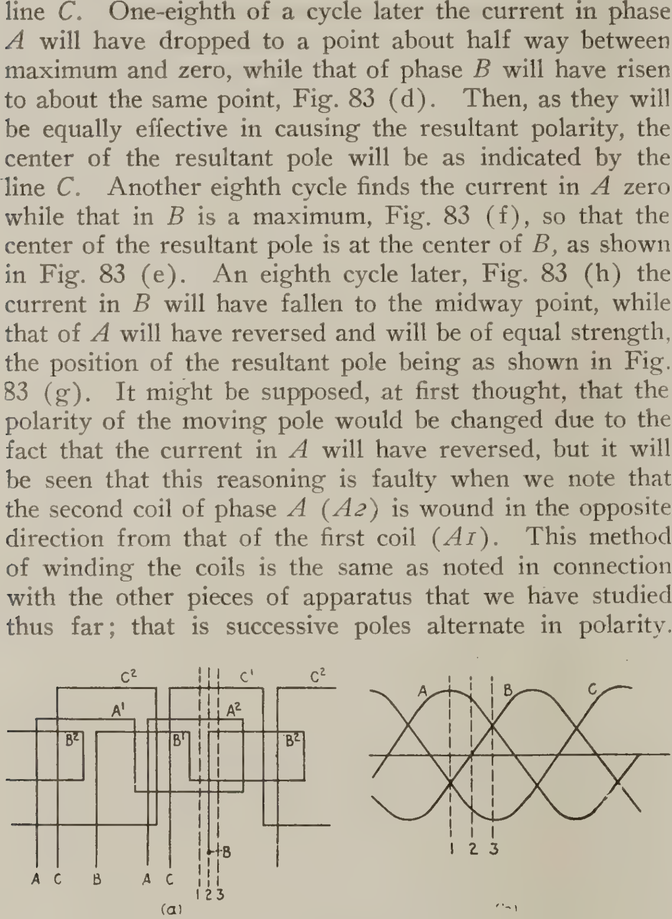


Fig. 84

The polarity of *A1* is at this time, however, south, so that it accommodates the moving south pole which follows the moving north pole we have been considering. This gradual movement of the pole continues throughout each complete revolution, as shown in the figures. The movement of the pole is actually by much smaller successive stages than we have indicated in the figures; we have only noted eight of the more convenient positions, but there are innumerable positions in between each of those we have noted. Thus the magnetic pole slides along rather than moving by jumps. Exactly the same condition results from the flow of current in the stator of the three-phase motor, the interaction of the combined magnetic fluxes of the three phases being such that the magnetic pole slides around the machine in the same manner as shown in this two-phase machine. From the detailed manner in which we have studied the two-phase machine it will hardly be necessary to so deal with the three-phase machine in order to make the action clear. Therefore, we shall just indicate three of the positions of the shifting pole as in views (a) and (b) Fig. 84.

We shall now look into the behavior of the squirrel cage induction motor under conditions of load. Suppose the rotor to be revolving and that a load is suddenly applied to the shaft, thus tending to slow the rotor down. As the rotor slows down its conductors cut across the lines of force emanating from the stator and a voltage is gen-

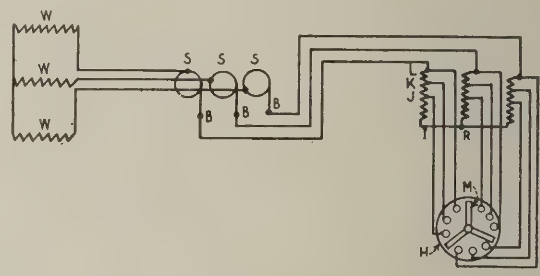


Fig. 85

erated in them. The strength of this voltage will depend on the amount that the rotor slows down. Thus if the rotor speed decreases five per cent the voltage generated in its conductors will be only half that when the rotor speed is decreased ten per cent. The amount of current that will flow in the rotor bars will depend, of course, on the strength of this voltage. The strength of the magnetic pole thus formed by the flow of current in the bars will, in turn, be governed by the strength of this current so that the pull or torque due to the attraction of the magnetic poles of the rotor and the stator will depend on the degree in which the rotor speed is reduced. Thus the current in the rotor and the loss in speed, or slip, as we learned it is called, will depend on the degree that the rotor is retarded by the load. In other words, they will depend on the load. Now the variation in the slip of an ordinary squirrel cage induction motor between no-load and full-load does not vary more than five per cent, so that we may class the squirrel cage induction motor as a constant speed machine. A four-pole induction motor of standard make rotates at a speed of 1,790 r.p.m. at no-load and 1,740 r.p.m. at full-load, the difference between the no-load and full-load speeds being 50 revolutions or about three per cent. Summing up it may be said that the squirrel cage induction motor adjusts itself to changes of load by slight changes of speed. The reason that the speed changes are so slight for a given change in rotor current, due to a given change in the load, is that the resistance of the ordinary squirrel cage winding is so small. Thus, a very small increase in voltage, due to a very small decrease in speed, will result in a rather large increase in rotor current. If the resistance of the squirrel cage be increased, then a larger increase of voltage will be necessary for a given increase of rotor current. In the case of the above-mentioned motor, if the resistance of the squirrel cage be doubled then the speed variation between the no-load and full-load positions will be doubled because it will be necessary to have twice the former voltage to

produce the same increase in current, and this increase in voltage can only be obtained through a decrease in speed. If we could vary the resistance of the rotor winding at will we should have a variable speed motor; that is, the speed of the motor for a given load could be varied by varying the amount of resistance in the circuit. Thus, if the speed at full-load were 1,740 r.p.m. we could, in the case of the particular motor mentioned above, cut the

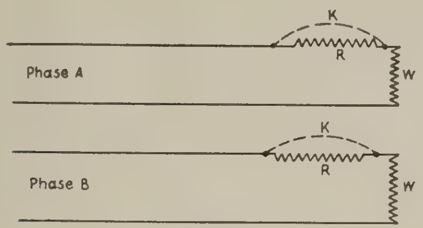


Fig. 86

speed down to 1,690 r.p.m. by inserting such a resistance in the circuit as would double its normal value of resistance. We could decrease the speed still further by the addition of more resistance. A practical means of accomplishing this purpose is by means of the wound rotor.

Fig. 85 is a diagrammatic view of a wound rotor, the

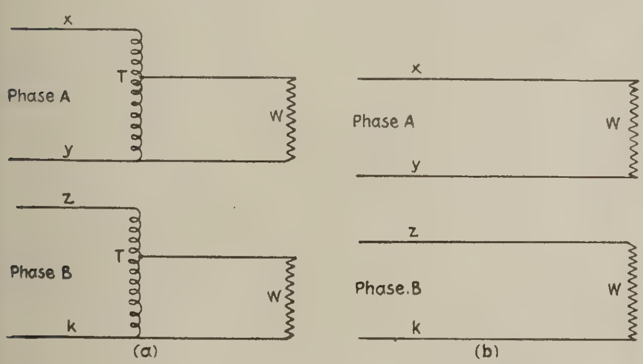


Fig. 87

winding being denoted by *W*, the collector rings by *S*, the brushes by *B*, the resistor by *R*, the contact dial by *H* and the contact arm by *M*. The winding is similar to that of the stator, being three-phase star connected; its terminals are brought out to the three collector rings, which are, in turn, connected to resistor *R*. The contacts on the dial are connected to taps taken off at regular points

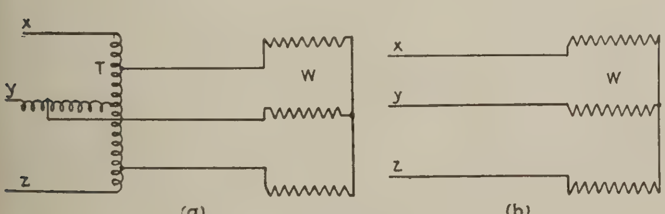


Fig. 88

on the resistor which is also star connected. The arm *M* consists of three similar contact arms rigidly connected together both mechanically and electrically so that three of the contacts are simultaneously connected together as the contact arm is advanced one step. This has the effect of moving the star connection of the resistor from *I* to *J* with the first movement of the contact arm; from *J* to *K* as it is advanced another step, and from *K* to *L*, where the resistance is all cut out of circuit, on the third and final step. Thus four possible speeds are obtainable for any given condition of load; the *L* or full speed, *K* speed, the *J* speed and the *I* or slowest speed. The rotor windings of practically all wound rotor induction motors are three-phase regardless of whether the stator is wound for two or three-phase. This will not seem so strange if we consider that there is absolutely no electrical connection between the rotor and the stator and that the rotation of the magnetic poles will be just the same regardless of whether the current flowing through the stator is two or three-phase. In the same way the current induced in the

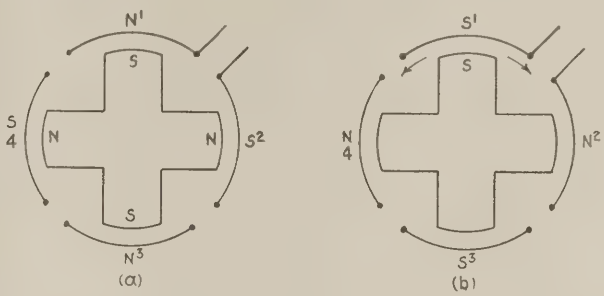


Fig. 89

rotor could be utilized just as well whether it were two or three-phase. The three-phase rotor winding happens to be the most convenient, for several reasons, so it is used almost universally for this purpose. One of the many reasons for preference being shown the three-phase winding is that for the average type of load a more even speed variation is obtainable with the winding and resistor being divided into three parts than would be possible if they were only didivided into two parts.

When a squirrel cage induction motor is connected to the line, the rotor acts the same as the short-circuited secondary of a transformer. An enormous current will

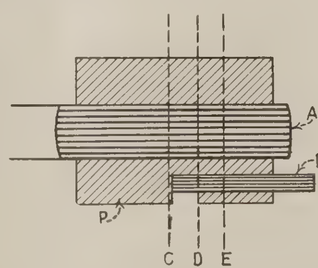


Fig. 90

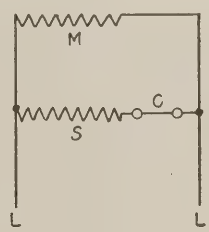


Fig. 91

be drawn from the line for a length of time depending on how long it takes to accelerate the load to a point where this transformer action is minimized. If the motor is not loaded at the time the duration of this high current will be only momentary so that its effect will be negligible, but if the motor is under load the current may continue for a length of time sufficient to cause damage to the windings of the motor or to the insulation of the transmission line. Even though it did not result in any such permanent damage as this it would produce objectionable line disturbance, causing a drop in voltage that would be noticeable on lights connected to the line at the time, not to mention the strain on the generating equipment. To

overcome this objectionable feature it is customary, on all motors larger than 5 hp. to reduce the voltage that is applied to the motor by means of a resistance connected in series with each of the phases, or by means of auto-transformers.

Fig. 86 shows a two-phase motor with resistances *R* connected in series with the windings *W* of each phase. This resistance serves to limit the current taken from the line at starting to some predetermined value that shall not be detrimental to the system. After the motor is up to somewhere near normal speed the resistance is short-circuited as shown by the dotted lines and the motor is connected directly across the line.

Fig. 87 shows the connection of a starting autotransformer as used on a two-phase circuit. The transformer is shown at *T*, the motor windings at *W* and the two sets of line wires at *x-y* and *z-k*, respectively. At starting the motor windings and the transformers are connected as shown in Fig. 87 (a) so that we get a lower voltage across the motor terminals throughout the starting period. This reduces the current taken from the line at starting and still allows the motor enough current to produce a large starting torque. When up to speed, or nearly so, the transformer is disconnected and the motor is then connected directly across the line as in Fig. 87 (b).

Fig. 88 (a) and (b) show the connections for starting a three-phase motor by means of auto-transformers.

In practice these auto-transformers are mounted so that connection between the starting transformers, the line wires and the motor may be made by the simple act of throwing a lever. Thus the lever is pulled toward the operator for starting the motor, making the necessary connections as in Fig. 88 (a) by means of a drum that is caused to revolve by the movement of the lever. After the motor has attained sufficient speed the operator pushes the lever from him, thereby making the proper running connections, as in Fig. 88 (b). The handle or lever is held in this position by means of a solenoid.

We shall now take up the study of the single-phase

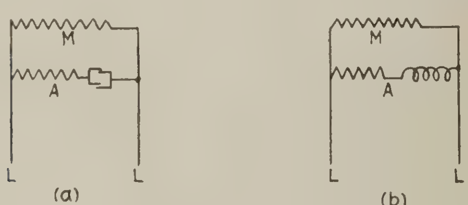


Fig. 92

induction motor. We have learned that the magnetic field rotated, in the case of the polyphase motor, but it does not do so in the case of the single-phase motor. Fig. 89 (a) shows the relative polarity of the rotor and stator poles at a given instant, while Fig. 89 (b) shows the condition a half cycle later. As the N^1 magnetic pole moves one-quarter of a revolution to the right (clockwise) it will tend to attract the *s* rotor pole. But N^3 will have moved to position N^4 and will attract *s* just as strongly as does N^1, the net result being that the rotor does not move in either direction and the magnetic field does not then revolve, but only reverses or pulsates. However, there are several ways of producing a revolving magnetic field similar to that of the polyphase motor. One of these is shown in Fig. 90.

Fig. 90 illustrates the shaded pole method of producing a revolving magnetic field with single-phase current. *P* is the magnetic pole which is, as shown in the illustration, similar to the field pole of a direct current machine in that it is of the salient type—salient meaning projecting. This is in contrast to the stator of the average a.c. machine, which has a slotted stator structure. The coil *A* excites the pole. A "shading" coil *B* consisting of a single turn short-circuited on itself, is imbedded in a slot cut at one side of the pole face. When the current through the field coil is at a maximum the center of magnetic flux will be at the center of the poles as denoted by line *c*. As the current begins to decrease the flux passing through *B* will change in intensity thereby generating a voltage in *B* and causing a current to flow through it in

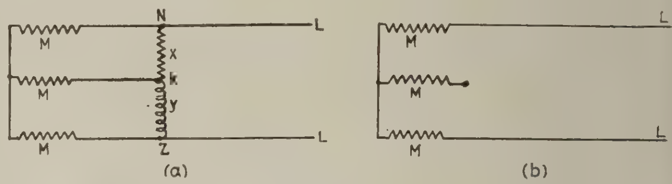


Fig. 93

such a direction as to assist the main coil *A* in maintaining the flux. Since the two coils are active, *A* at the center and *B* to one side of the center, the center of flux will shift to point *d*. Then when the current in *A* is passing through the zero point the current through *B* will be at a maximum, because the flux is then changing at the greatest rate, and the center of flux will have shifted, to point *e*. Thus the flux will appear to move in a definite direction, the result being that there is a greater tendency for the rotor to move in one direction than in the other at the time that the polarity of the stator reverses and the rotor will revolve. This method of producing rotation does not result in a very great starting torque so that it is only applicable in the case of small loads such as desk fans and other like cases where the load is gradually increased as the rotor speeds up.

The most common means of producing a revolving single-phase flux is, perhaps, by the split phase method which is illustrated in Fig. 91. There are two windings on the stator spaced as are the windings of the two-phase motor—90 degrees apart. The winding *M*, called the running winding, is connected to the line as long as switch *L* is closed—i.e., as long as the motor is operating. Winding *S*, called the starting winding, is only connected to the line during the starting period, its circuit being opened by means of an auxiliary switch *C* after the motor has attained normal speed. Winding *M* consists of many turns and a comparatively low resistance so that the current through it will lag behind the voltage considerably, especially during the starting period. On the other hand winding *S* consists of few turns and high resistance so that the current through it will be nearly in phase with the voltage. Thus the currents in the two windings will be nearly 90 degrees apart and a revolving field will be produced in the same way as in the two-phase motor. When the motor has attained a speed of about 80 per cent of normal, switch *C*, which is mounted on the rotor, is opened by centrifugal force, due to the speed of rotation, and then only winding *M* is connected to the line. The rotor will continue to revolve, however, because momentum will carry it along in a given direction while the flux is pass-

ing through the zero point so that when the flux has reversed the attraction to the nearer pole will be greater than that of the further pole and rotation will continue unhampered. This type of single-phase motor is widely used on motors smaller than one-half horse power.

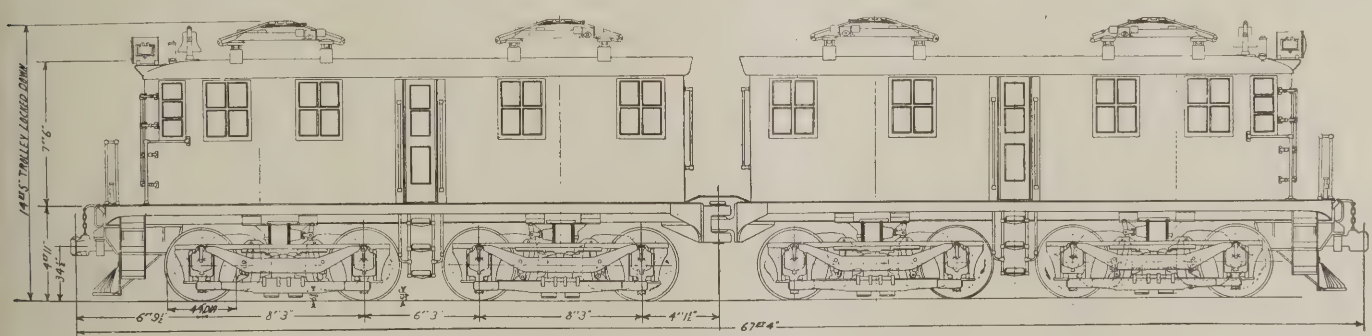
Another method of phase splitting not so commonly used is illustrated by Fig. 92. This motor contains the two windings as in the type of motor just described, but the splitting of the phases is accomplished in a different manner. The two windings *A* and *M* are similar as regards number of turns and resistance, but one of them has a reactance connected in series with it so that, as in the above case, the currents through the two windings are 90 degrees out of phase with one another, and a revolving field is produced. In Fig. 92 (a) winding *A* has a condenser connected in its circuit, while in Fig. 92 (b) it has an inductance connected in its circuit. The result is the same in both cases, so far as accomplishing their purpose, but it will be seen that the current in *M* lags behind that of *A* in Fig. 92 (a) while it leads that of *A* in Fig. 92 (b).

One other method of starting single-phase motors is illustrated by Fig. 93. The stator is wound exactly as a three-phase motor stator, the terminals of the star connected winding being brought out to terminals *N, K* and *Z* of an external starter Fig. 93 (a). This starter contains a resistance *x* and a reactance *y* connected together at *K* and terminating at *N* and *Z*. Upon connecting the line wires to *N* and *Z* a revolving magnetic field similar to that of a three-phase motor is established in winding M by the action of the combined resistance and reactance. When the motor has attained nearly normal speed the connections are changed as in Fig. 93 (b) so that the stator is disconnected and only two terminals of *M* are connected to the line wires, the other terminal not being used. This is done because the losses in the starter have been found to be greater than the advantage of increased power obtainable through having the whole stator winding active at all times. There is one other type of single-phase motor in common use, but it will be taken up under the head of repulsion motors.

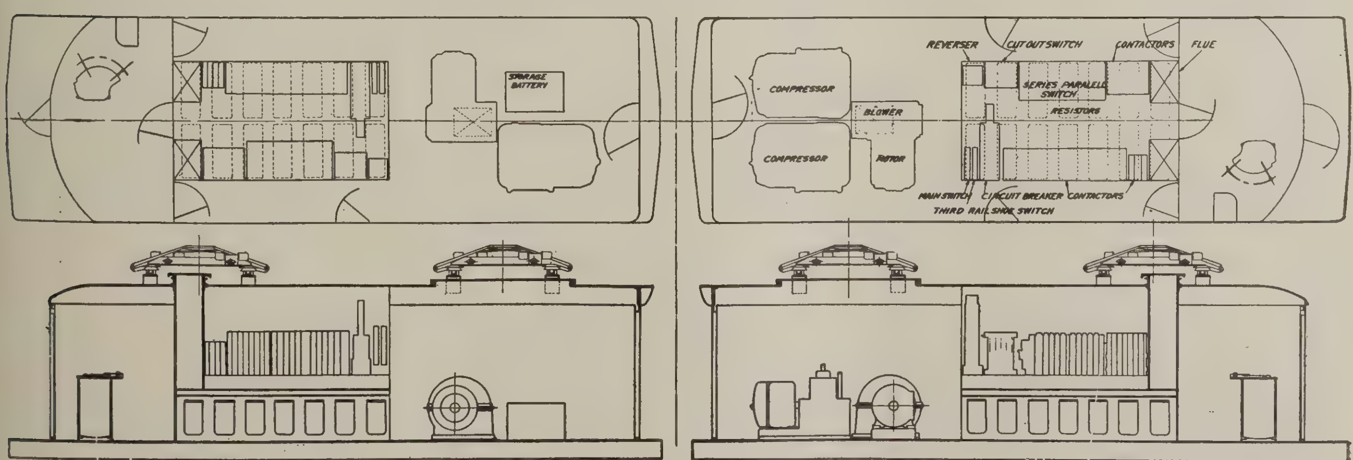
Freight Locomotives for the New York Central

Switching and Road Engines Will Be Tried Out for Service on West Side Track in New York City

THE New York Central has placed orders with the General Electric Company for seven 100-ton electric switching locomotives and two 170-ton electric road freight locomotives, to be put in service on the electric division in New York City and vicinity. These locomotives will be tried out, in anticipation of the future electrification of the West Side freight tracks running from Spuyten Duyvil to Canal Street in the City of New York. The locomotives, which are being built jointly by the General Electric Company and the



Articulated, 170-Ton Road Freight Locomotive

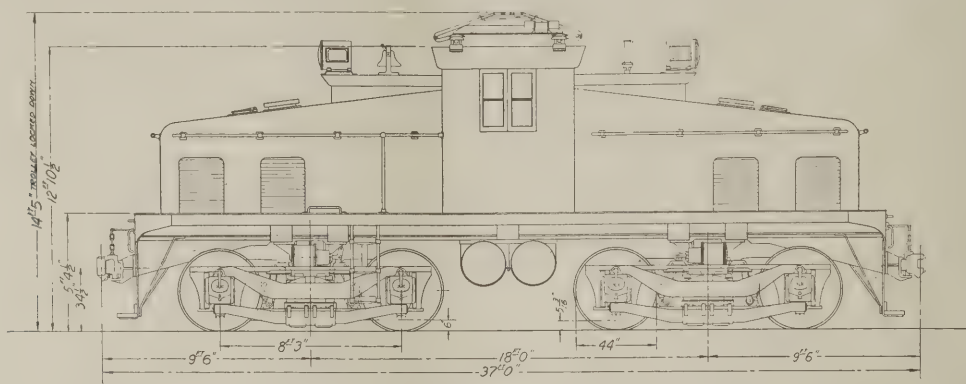


Arrangement of Apparatus in Road Freight Locomotive

American Locomotive Company, will be equipped for both third rail and overhead collection of current.

The specifications for the switching locomotives provide for hauling a 1,500-ton trailing train, consisting of 75 per cent empties and the balance of loaded cars, at a speed of not less than 25 miles an hour. The road locomotives will haul a 3,000-ton train of the same general make-up, at 32 miles an hour.

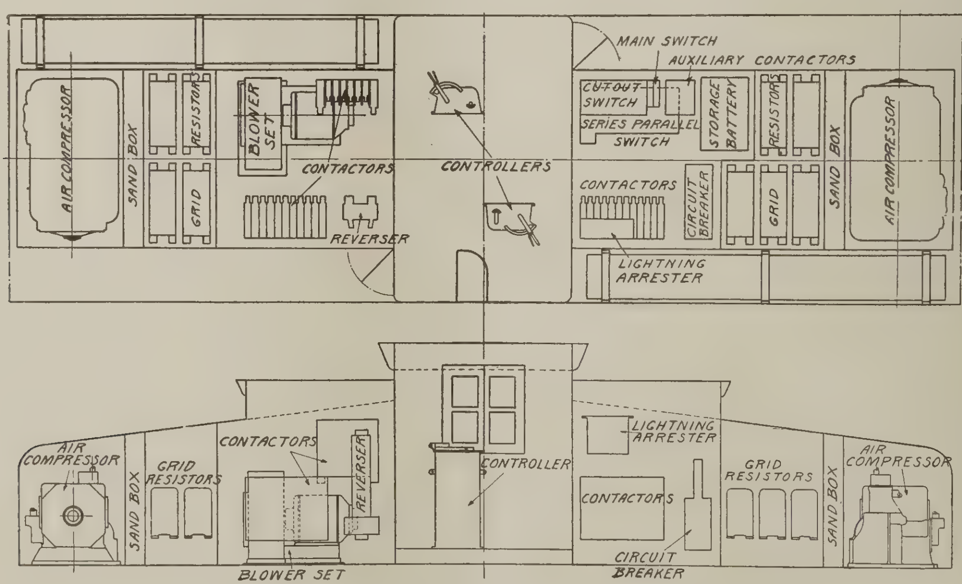
The switching locomotives are of the steeple cab type, carrying two swivel, equalized trucks equipped with four GE-286, 600-volt motors. The nominal continuous rating of these locomotives is 1,240 horsepower, or approximately 310 horsepower per motor. A 72/17 gear ratio is used with the cushion type gear. This has given satisfactory service on the Paulista locomotives, and is being used with similar success on the Mexican Railway Company's locomotives.



100-Ton Electric Switching Locomotive

The cab platform consists of an integral steel casting. A master controller is provided at the engineer's position on each side of the cab, and the control and auxiliary apparatus is installed in the sloping end cabs.

The control is type PCL, operating from a 32-volt storage battery. The 32-volt supply, in addition to operating all control circuits, is also used for cab lighting and for headlights. The type of control eliminates high voltage from the master controller and employs electro-pneumatic contactors located in the end cabs for operating the main circuits. Remote control is used for all accessories, including blower motor circuit, compressors, reversers, etc. Protection against overload or short circuit is obtained by a high speed circuit breaker connected in the high side of the main supply. An additional protection against injury to the individual motors is provided by overload relays in each motor circuit. These are so arranged that a short circuit on an individual motor will trip out the high speed breaker. The battery is charged by being connected in series with the blower motor. To protect against over-charging, a by-pass resistance is used in parallel with the battery, thus reducing the charging current. The use of this resistance is controlled by an ampere-hour meter.



Arrangement of Apparatus in Switching Locomotive

The master controller is of the standard design, using three handles—the main operating handle, a reversing handle, and a reduced field handle. Three full running speeds are provided, with the motors in series, series parallel and full parallel. In addition, two reduced field steps may be used with each motor arrangement, giving a total of nine free running speeds. Two CP-26 compressors provide a total of 200 cubic feet displacement at 130 pounds pressure for the air brakes. Other accessories

include a motor-driven blower located in the end cab for ventilating the traction motors, a bell and whistle mounted on the roof, and equipment of air-operated sanders.

Road Freight Locomotives

The running gear for the freight locomotives is similar to two switching locomotives coupled by an articulated joint, and the motor and control equipment duplicate those used on the switchers. A gear ratio of 69/20, however, is used, giving a higher running speed and permitting a maximum speed of 60 miles an hour. Two box type cabs are provided. These are carried on cast platforms similar to those used in the switchers. Two compressors, giving a total displacement of 300 cubic feet of free air at 130 pounds pressure, will be installed. The box cabs will be somewhat similar in appearance to the present passenger locomotives, having rounded ends of the same general character. A high speed circuit breaker will be installed in each cab, protecting each half unit independent of the other. The pantographs are of the hornless design, operating through a range of 25 inches. Two of these are mounted on each cab. In order to operate over the present electric division and such portion of the West Side tracks as will be equipped with third rail, shoes are provided on both sides of each truck.

One of the novel details is the provision of forced grease lubrication for the pins in the spring rigging. A bell and whistle are also provided on each cab. All locomotives will be equipped with solid rolled steel wheels, in accordance with the railroad company's specifications. A delivery of approximately 12 months is promised for the order. Provision is also made for a complete set of tests, to be made by the General Electric Company and the New York Central jointly after delivery.

Principal Data

	Road engine	Switcher
Length	67 ft. 4 in.	37 ft. 0 in.
Height (pantograph locked down)	14 ft. 5 in.	14 ft. 5 in.
Wheel base	53 ft. 9 in.	26 ft. 3 in.
Rigid wheel base	8 ft. 3 in.	8 ft. 3 in.

Maintaining Train Control Equipment

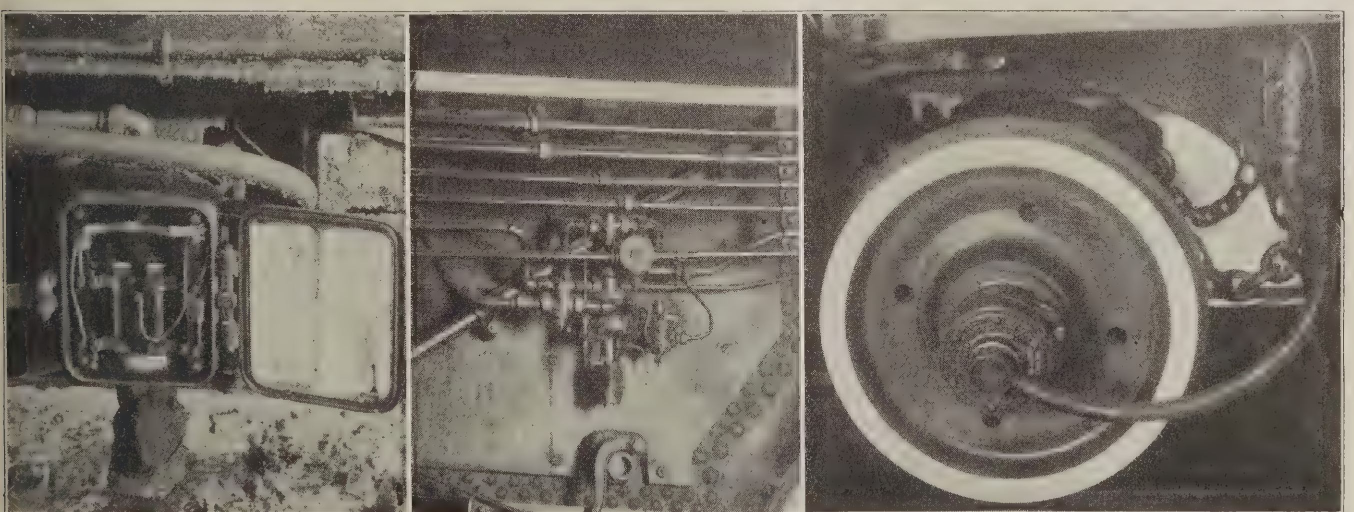
Regular Electrical Maintenance Men at Enginehouses and Back Shops Absorb Most of the Work

By E. Wanamaker
Electrical Engineer, Chicago, Rock Island & Pacific

THE equipment or devices necessary to an automatic train control system include roadside equipment which properly lies within the province of the signal department, and locomotive equipment which comes under the jurisdiction of the mechanical department. The chief mechanical officer is in a position to combine and utilize the skill of the electrical engineer, the mechanical engineer, the air brake engineer, and all others familiar with locomotive operation and maintenance. Familiarity with the many peculiarities of locomotive equipment and devices is a prime requisite.

Train Control Supervisor Should Be Appointed

In order to co-ordinate successfully the efforts of all these in the mechanical department, it is highly advisable, if indeed not absolutely necessary, to appoint a supervisor of automatic train control. This man should preferably be one who has had considerable experience in locomotive mechanical, electrical, and air brake work, as well as some experience in engine service. He will then be better qualified not only to co-ordinate the efforts of those in the mechanical department, but to secure the co-operation of those in the signal department and at the same time enlist the necessary support of the division transportation officers. The successful operation of automatic train control depends quite largely on the skill and fidelity of the division officers functioning under the supervision of the automatic train control supervisor insofar as automatic train control is concerned.



Open Shoe Box, Electro-Pneumatic Valve and Speed Controller—Parts Which Must Be Maintained

The following paragraphs refer to automatic train con-

trol as applied to 165 miles of double track between Blue Island and Rock Island, Ill., on the Chicago, Rock Island & Pacific. The system as now installed is of the intermittent electrical contact type, with 240 ramps installed and 103 locomotives equipped.

Automatic Train Control Operation

Last February the operating rule requiring a train to stop at an automatic stop signal indicating stop, after which it may proceed through the stop block at a speed not to exceed eight miles an hour, was changed so that on all locomotives equipped with the automatic train control in operation the engineman may, upon reducing his speed to below 15 miles an hour, pass the stop signal without stopping and proceed, thus eliminating the stop at the stop signal.

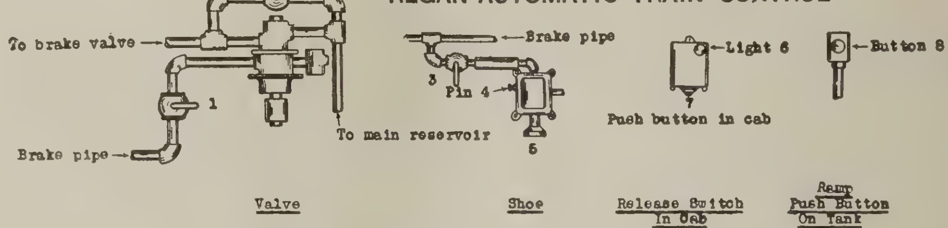
As long as the signals are all clear there is no action of the automatic train control device. If approaching and passing a caution signal above a certain prescribed speed (in the case of a passenger train this speed is 30 miles an hour and for a freight train 25 miles an hour) an automatic brake application will result. This will reduce the speed of the train to within the prescribed limit, and upon arriving at that speed an indicator light is shown in the cab, which is the engineer's indication that he may release the brakes. Upon so doing he can proceed but only at the prescribed limit or speeds below. If he should not be alert for some reason or other and fails to operate the release, then the train will be stopped. Upon continuing through the caution block, if he should happen to exceed the caution limit, another application will result, necessitating a second operation of the release.

Upon approaching the stop signal, and if he should pass it above the prescribed speed, which is 15 miles an hour for both passenger and freight service, an automatic application of the brakes will result and the same releasing operation must be carried out as explained for the caution signal. However, if he should pass this stop signal below 15 miles an hour (having operated a secondary push button which is on the tank and inside the gangway) he can pass over the ramp without an application. If that button is not pushed while he is running below the prescribed speed of 15 miles an hour he will get an application, no matter at what speed he is running, whether it be one, five or ten miles an hour. After he has passed the stop signal, if he should exceed the speed of 15 miles an hour or reach that speed at any time, he will get an application which will necessitate a release. If the next signal is clear, his high speed is restored and he can proceed at unlimited speed.

The roadside apparatus used is a ramp located at each signal, the energy supply to the ramp being from a roadside battery controlled by the signal circuits. The locomotive apparatus consists of the shoe mechanism located on the No. 1 tank truck; an indication selector or relay and storage battery; the speed controller on the No. 1 engine truck wheel; an electro-pneumatic reservoir and brake valve, with an exhaust control valve and suitable cocks arranged so as to cut the apparatus out in case it should be necessary; release switch; and tank button, all suitably connected by conduit and wire.

FORM M. P. 36

ROCK ISLAND LINES
INSTRUCTION CARD
REGAN AUTOMATIC TRAIN CONTROL



1. TO CUT DEVICE OUT OF SERVICE: Close cock 1 so that handle is in line with pipe and open cock 2 on bypass so that handle is crosswise with pipe. In case of heavy leak of air at shoe box also close cock 3 so that handle is in line with pipe.

2. TO PLACE DEVICE IN SERVICE: Open cocks 1 and 3 so that handle is crosswise with pipe and close cock 2 on bypass so that handle is in line with pipe.

3. DOUBLE HEADING: When double heading, on rear engine Raise shoe stem 5 to full height; pull out locking pin 4, give it one-quarter turn and see that it has entered the slot full length.

4. OPERATION:

(a) The train control apparatus does not interfere with the proper observance of rules governing air brake operation.

(b) CAUTION SIGNAL will enforce speed throughout the block **not to exceed 30** miles per hour for passenger trains **and 25 miles per hour for freight trains. To avoid** unnecessary application of the brakes, speeds should be maintained below these limits.

(c) STOP SIGNAL: At a stop block, ramp push button number 8 on tank must be pushed in before shoe engages ramp, and held in so long as shoe is on ramp. If stopped with shoe on ramp, button 8 must be pushed in and held in until shoe is off ramp.

(d) A stop signal will enforce speed not to exceed 15 miles per hour throughout the block for both passenger and freight trains. To avoid unnecessary application of the brakes, a speed should be maintained below that limit.

(e) RELEASE SWITCH IN CAB: Whenever device makes brake pipe reduction, place brake valve in lap position until train is running below prescribed speed; then when indicator light 6 is displayed, push the button 7 which will extinguish the light, and proceed to follow prescribed rules of proper air brake operation as though you had made the application yourself.

(f) IN CASE OF IMPROPER OPERATION: Should the device improperly apply the brakes, it must not be cut out of service until the ramp next ahead has been passed. The only exception to this rule will be permitted when, with the train at stop, it is impossible to release the brakes after pushing button 7.

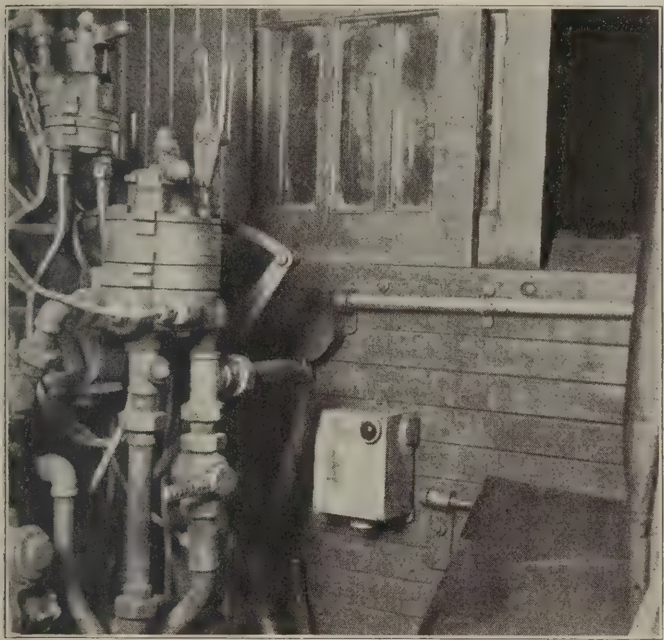
(g) Report any improper working of the device to the Train Dispatcher and on work report.

Card Placed in the Cab for the Instruction of Enginemen Regarding Train Control Operation

The Electrical Engineer Has General Supervision

The automatic train control is supervised by the electrical engineer who acts more or less as the directing and consulting engineer in connection therewith. The supervisor of automatic train control, reporting directly to the superintendent of motive power of the first district, also works in direct contact with the superintendent's office. A clerk is employed in the superintendent's office to fol-

low in detail the operation of each locomotive, compile information and data, and quickly transmit to the supervisor of automatic train control any irregularity of operation that shows up, for his immediate attention. This clerk is one of the most important links in train control

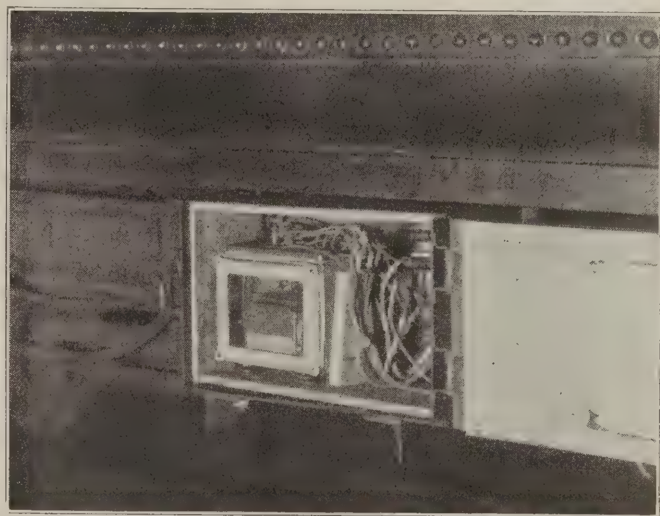


Cab Indicator and Release Button

operation. He should be a man of considerable ability. He is charged with the responsibility of interpreting the reports from the various maintenance points and train dispatcher and following them up for corrective action when necessary.

Automatic train control locomotive maintainers are located at the various locomotive terminals on the division, of which there are five maintenance points, two at Chicago, one at Peoria, Ill., and two at Rock Island, Ill., the western terminus of the division. In general the

The maintainers report to the roundhouse foremen, who are responsible for the locomotives getting out on time and in satisfactory condition, both as to mechanical features and electrical features. Therefore, it is highly important, if not the most important duty of the supervisor of automatic train control, to see that good relations exist between the maintenance forces and the roundhouse authorities, and to act in accord with the roundhouse forces; to make of himself a good influence on the division, looked up to and respected by every operating officer concerned in both the transportation and mechanical departments as well as soliciting the unqualified sup-



Relay Box—One Reason Why Maintainers Must Understand Electrical Circuits

port of the enginemen. The degree of success he makes in this direction is an important factor in the smoothness, quickness and intelligence with which the train control is maintained and operated. He must become well acquainted with the enginemen, firemen, trainmen and conductors; he must so conduct himself that these men will

ROCK ISLAND LINES

SEMI-ANNUAL INSPECTION REPORT AUTOMATIC TRAIN CONTROL
LOCOMOTIVE APPARATUS

INDICATION SELECTOR														Stick Release Switch		Electro-Magnet			
Motor								Clutch Release		Mechanical Lock									
Drop-Away				Pick-Up				High Speed	Med. Speed	Pick-up		Drop-away		Release		Pick-up		Drop-away	
High Speed		Med. Speed		High Speed		Med. Speed													
Volts	Amps.	Volts	Amps.	Volts	Amps.	Volts	Amps.	Amps.	Amps.	Volts	Amps.	Volts	Amps.	Volts	Amps.	Volts	Amps.	Volts	Amps.:

Semi-Annual Inspection Report Forwarded to the Electrical Engineer's office

regular electrical maintenance men at enginehouses and back shops absorb most of the work so that comparatively few maintainers are needed and the working hours of these men are arranged to meet the requirements of the engines dispatched. In other words it is not always necessary to have a maintainer and helper on each shift at each of the maintenance points. The work of these men is arranged so as to utilize fully the available man power.

look to him for information and advice and depend upon him implicitly in train control matters.

The train control apparatus is maintained in a similar manner to any other locomotive appliance; that is, the engineman, upon arrival at a terminal fills out in a space provided on his engineman's work report, the condition of the automatic train control apparatus. If some repairs are necessary a work slip is made out from this work

report the same as for any other part of the locomotive, and handed to the train control maintainer. The train control maintainer makes such inspection and repairs as are deemed advisable and reports back to the foreman, signing the work report accordingly. At the end of each this way a complete and accurate record of the operation of the automatic train control is compiled.

In addition, a report form called "The Record Card" is carried on each locomotive. Any repairs made are noted on this report form each time a locomotive enters

Form MP 116

Record Card
Automatic Train Control

Battery Applied No.______ Date______

Speed Circuit Controller Set and Tested { Medium______ Date______ ; Low______ Date______

Engine No.______

Month______

Date Tested { Magnet______ ; I. S. Relay______ ; Release Switch______

Speed Circuit Controller Greased (Date)______ R. & B. Valve Cleaned and Tested (Date)______

Date	Brake Appl. Lbs.	Shoe Gauge	Gravity	A. T. C. Working on Arrival	REPORT HERE ANY WORK DONE	Place	Maintainer's Name
1							
2							
3							
29							
30							
31							

Note #1 When changing cards transfer Speed Circuit Controller greasing, setting and testing dates, battery number and application date, R. & B. Valve cleaning and test date, Magnet, I. S. Relay and Release Switch testing date to new card.

Note #2 Speed Circuit Controller must be greased every 60 days, R. & B. Valve cleaned every 6 months, I. S. Relay & Release Switch tested every 12 months, and Magnet tested every 6 months.

Note #3 Forward card from first terminal reached on last day of month to Electrical Engineer, Chicago, Ill. inserting new card as instructed in Note No. 1.

Note #4 Note on back of card any defects or trouble encountered.

Train Control Record Card 8½ In. by 11 In. in Size Which Is Carried on Each Locomotive

day, another form called "The Automatic Train Control Inspection Report," is filled out, giving a record of all locomotives arriving at that particular terminal, the condition on arrival, and any remarks considered necessary to explain the condition of the train control equipment. a locomotive terminal and at the end of the month the card is removed and mailed to the electrical engineer's office in order that he may have a complete history of the operation of each locomotive at all times.

To understand, operate and maintain automatic train

R. I. **ROCK ISLAND LINES** Form M. P. 114

DAILY INSPECTION REPORT AUTOMATIC TRAIN CONTROL

LOCOMOTIVE EQUIPMENT

Time 12:01 a. m. to 12:00 p. m. Place______ Date______

Eng.	Train In No.	Train In Interruption	Train Out	Battery	Ind Selector	Shoe Box	Stop Ramp Buttons	Release Switch	R & B Valve	Speed Controller	Wiring	Conduit	Piping	Condition When Disp.	Cond. Form M. P. 36	REMARKS

Total Engines Dispatched______

SIGNED: R. H. Foreman______ ______
R. H. Foreman______ ______
Maintainer______ ______
Maintainer______ ______

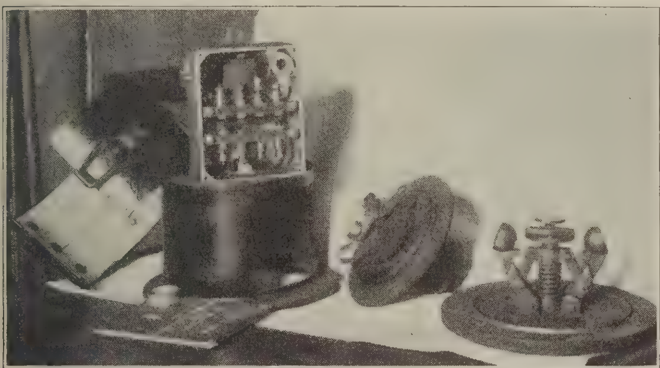
Roundhouse Foreman must not O. K. a Train Control Equipped Road Engine for service unless Train Control is in operating condition.

Inspection Report Filled Out Daily by Enginemen on Arrival of Locomotives at Terminal Points

This form also gives a record of all locomotives departing from the terminal and the condition in which they were dispatched. It is mailed to the superintendent's office for the files of the automatic train control clerk, one copy being retained in the roundhouse foreman's office. In control intelligently it is imperative that the electrical engineer, train control supervisor, and maintenance forces be thoroughly familiar with the theory of application, maintenance and operation of the air brake systems, not only on the locomotive but upon all rolling stock. They

must have an intimate knowledge of locomotive operation and maintenance. They should also have sufficient knowledge of the operation of the signal system upon which the train control has been superimposed to have an understanding as to the control of the roadside element by the signal.

The reservoir and exhaust control valve, which is the air appliance of the automatic train control equipment, is inserted in the air brake lines of the locomotive, and unless the maintainer has sound knowledge of the air brake system, it is easy for him to become confused, resulting in confusion of installation and operation of the air brake equipment of the locomotive as well as of the



Parts of Speed Controller and Open View of Release Box

automatic train control system. For instance, a defective feed valve has caused violent fluctuations of the train line air gage on the locomotive, resulting in the cutting out of the automatic train control by the engineman, and it becomes necessary for the train control forces to be able to detect and explain satisfactorily to the engineman what his trouble actually was. The train control organization must also know the effect of air brake applications upon moving trains, particularly freight trains, and the effects of various reductions and rates of reduction upon the slack action of the trains, as they will be called upon from time to time to discuss these things with enginemen in order to bring about a more complete understanding of train control and its operation.

They must understand locomotive conditions as they develop in operation in order to handle the train control equipment properly. For instance, locomotive tender truck wheels develop flat spots occasionally and begin to pound so severely that the train control attachments become disturbed. They loosen up and the supervisor or maintenance men must pick out these cases for correction by the roundhouse forces. They must be acquainted with all of the government requirements as to clearances, arrangements, etc., that are wrapped about the maintenance of locomotives, so that the train control will not interfere in any way with these requirements. They must work hand in hand with the air brake repairmen and engine inspectors in order that complete co-ordination with air work may result. Their operations must be so conducted as to create a feeling of good fellowship among all concerned.

Maintainers Need Working Knowledge of Signals

The mechanical department automatic train control maintainers should have a working knowledge of that part of the signal system that controls the roadside elements; that is, they should have a general understanding as to how the different indications are transmitted to the ramp in accordance with the signal indication. This is necessary in order that they can interpret such operations as reported applications of the brakes at a clear signal, etc., particularly where it is the only signal encountered on the trip, at which such an application was received. After inspecting the train control equipment and finding it to be in good condition, it should be possible for them to report to the train dispatcher that the signal in question probably has defective roadside apparatus.

Inspections and repairs of the indication selector, release switch and magnet are reported on one of the forms illustrated, being filled out semi-annually and forwarded to the electrical engineer's office.

The general instructions for automatic train control operation and maintenance are contained in a 38-page pocket size book of rules and instructions issued to all concerned. Electrical engineer's circulars are issued from time to time as necessary, giving detail instructions for the maintenance of the automatic train control equipment. Some important detail instructions for enginemen are contained in an instruction card, illustrated. One of these cards for ready reference is placed in the cab of each locomotive equipped with automatic train control.

Train Control Assists Mechanical and Operating Men

The results of the operation of train control are particularly interesting and important to the mechanical department. It is permissible for trains hauled by locomotives equipped with automatic train control in operating condition to pass an automatic stop signal indicating "Stop" without bringing the train to a full stop, as a reduction to below the low prescribed speed limit of 15 miles an hour, and the continuous control of this speed through the red block, has obviated such a necessity. All mechanical men, traveling engineers, road foremen of equipment, etc., fully realize the importance of not bringing a train to a stop except when absolutely necessary. The elimination of unnecessary stops results in economy of fuel, reduces the number of drawbars pulled out and lessens wear and tear on equipment, such as draft gear, drawbars, knuckle pins, brake riggings, etc., all of which helps to reduce in a very large measure the operating and maintenance costs.

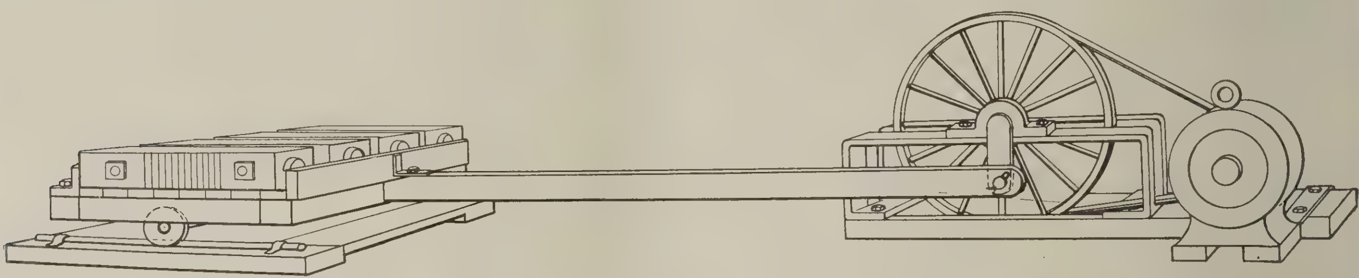
The automatic train control clerk in the division superintendent's office is constantly in close touch with the entire train control situation through the chief dispatcher, also directly by telephone or telegraph with the shop and roundhouse foremen, and in daily contact with the trainmaster. This close contact, together with the regular form reports, including emergency or trouble wire reports, enables the automatic train control clerk to keep a close check on each individual locomotive and signal equipped with automatic train control, handling any trouble for immediate correction. At the end of the month he makes an analysis sheet from his daily records kept for eash locomotive, etc., and from this analysis sheet forms his monthly report for the chief operating officer and the Interstate Commerce Commission.

These monthly reports on the Rock Island show a steady improvement in both operation and maintenance as our knowledge and experience with the train control equipment increases.

A Shaker for Edison Batteries

By Charles W. Graf, Electrician
Pennsylvania Railroad, Baltimore, Maryland

In the process of removing sediment from Edison batteries, some means for shaking the cans vigorously is required. Numerous schemes have been tried to accomplish this result, but the one shown in the illustration I have found to be most satisfactory. We have been using this machine for two years and it does excellent work; in fact, it may be considered as doing this battery shaking better than would be possible for 4 men to do it, as the solution in the cans moves with a churning motion which completely cleans the cells.



A Motor-Driven Shaker for Cleaning Sediment from Edison Batteries Which Can Do the Work of Four Men

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Fuse Protection for a Voltammeter

When using a portable type voltammeter in making tests requiring low current readings, it sometimes happens that the low reading ammeter scale is inadvertently connected across the battery voltage; as a result, the instrument may be seriously damaged. To prevent such a disaster another terminal post may be installed which is connected to the positive post of the meter by a fuse wire. The capacity of the required fuse depends on the meter, but a 3-ampere fuse is recommended. When taking higher ammeter readings, this fuse will, of course, be bridged, but the instrument is protected for all other readings.

Placing Concrete in Cold Weather

It is frequently quite a problem to place concrete so that it may be kept from freezing and allow it to harden in the normal time. The freezing is the most important thing to avoid, for when the mixing water turns to ice, it immediately stops the setting action of the cement. The disrupts the particles and makes the concrete weak or practically useless.

It is no longer considered good practice to attempt to prevent the freezing of the mixture by salt, for this only lowers the freezing point a very few degrees and has a very bad corrosive effect upon any steel that may be embedded in the mixture. The best practice for mixing concrete in the winter time is to have all of the materials formation of ice crystals within the partly set concrete as warm as possible. In other words, heat the water, sand and stone before mixing. After the mixture has been placed in, protect it with canvas or tarpaulins or other means, until the concrete has thoroughly hardened. Floors, drives or sidewalks which have large exposed surfaces, should not be attempted in the winter time unless extraordinary protective measures are taken, as the frost coming out of the ground is liable to play havoc with the work. Where it is at all possible, it is desirable to supply artificial heat by means of a small stove until the concrete is thoroughly set. Even after all precautions have been taken do not remove the forms too soon because under ideal conditions, the concrete cannot gain in strength as quickly in the winter as it does in the summer. It is easy to mistake frozen concrete from that which is properly hardened, but by the application of a blow torch it may be readily determined whether the mixture has hardened properly or is merely frozen.

How to Tell the Resistance of Wire Without Table

The B & S wire gage has some easily memorized features from which an approximate table can be kept in mind. The items to remember as approximately true, are as follows:

No. 1. A No. 10 wire has a diameter of 1/10 in. and a resistance of 1 ohm per 1,000 ft.

No. 2. Increasing the wire, size 3 doubles the circular

mils and halfs the resistance, or decreasing the size 3 numbers, halfs the circular mils and doubles the resistance.

For example: To find the resistance and size per 1,000 ft. of number 1 cable; consider that a number 10 wire has a diameter of 1/10 in., or 100 mils, and therefore, an area of 100 x 100 or 10,000 circular mils, approximately. Increasing the size in steps of 3 numbers, number 7 would be 20,000, number 4, 40,000 and number 1, 80,000 circular mils. The wire table shows this is approximately correct. Resistance per 1,000 ft. of average conductors is for number 10, 1 ohm, number 7, ½ ohm, number 4, ¼ ohm, and number 1, ⅛ ohm, or 0.125 ohm, which agrees with the table. For sizes that do not happen to fall on the 3rd number from the starting point, the results may be obtained approximately. It should be noted that the diameter does not increase in the same proportion of the area but that it doubles exery 6th instead of every 3rd size.

Famous Fairy Tales

"Not guilty."
"Prohibition."
"Glad to see you."
"The line is busy."
"It was his fault."
"The honest dollar."
"Plenty room inside."
"Love, honor and obey."
"The brakes were weak."
"No man can fill my job."
"I cannot live without her."
"The world owes me a living."
"The world is growing better."
"I will pay you back tomorrow."
"I can beat the train to the crossing."
"The government ought to run the railroads."
"Buy this mining stock and you will be a rich man in six months."

Ain't It the Truth?

I have just learned of an editor who started poor twenty years ago and retired with a comfortable fortune of $50,-000. This was acquired through industry, economy, conscientious effort, indomitable perseverance, and the death of an uncle who left him $49,990.

The Vacation Problem

"You give your clerks two weeks' vacation every year, don't you, Mr. Tintack?" asked a friend.

"A month," grunted the hardware dealer.

"A month?"

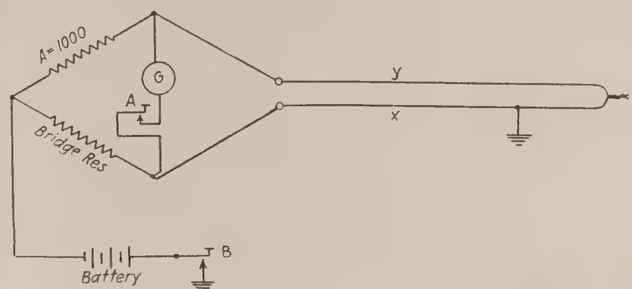
"Yes. The two weeks when I go on my vacation and two weeks when they go on theirs."

Answers to Questions

1. *How is a Wheatstone Bridge used in locating faults in underground and in aerial telephone cables?*

Locating Grounds In Telephone Cables

The Wheatstone bridge as manufactured today for commercial purposes, is so designed that it can be connected up in many different ways. In last month's issue of the *Railway Electrical Engineer,* this equipment was shown as it would be connected to measure an unknown resistance. In this connection the bridge was shown with four arms, one of which contained the unknown resistance. In the present consideration, the bridge is connected up quite differently. By examination of the figure it will be seen that the long loop of wire designated as x and y, is attached to the terminals of the bridge. This loop of wire represents a pair of conductors in the telephone cable



Schematic Diagram of a Wheatstone Bridge Connected for Locating Ground in Telephone Cable

and it is assumed that one of these conductors is grounded. At the distant end of the cable the ends are joined together forming a closed loop. A careful inspection of this diagram will show that the two parts of this loop, namely, x and y, correspond exactly to the other arms of the bridge used in measuring a resistance.

In making a test, arm A is set at 1,000 ohms while the bridge is balanced by adjusting the bridge resistance. About 15 volts of battery is sufficient to use for this purpose.

When a balance has been secured, that is, when the galvanometer needle does not move when both keys A and B are closed, the bridge reading may be substituted into the following formula:

$$x = \frac{\text{Bridge}}{A + \text{Bridge}} L$$

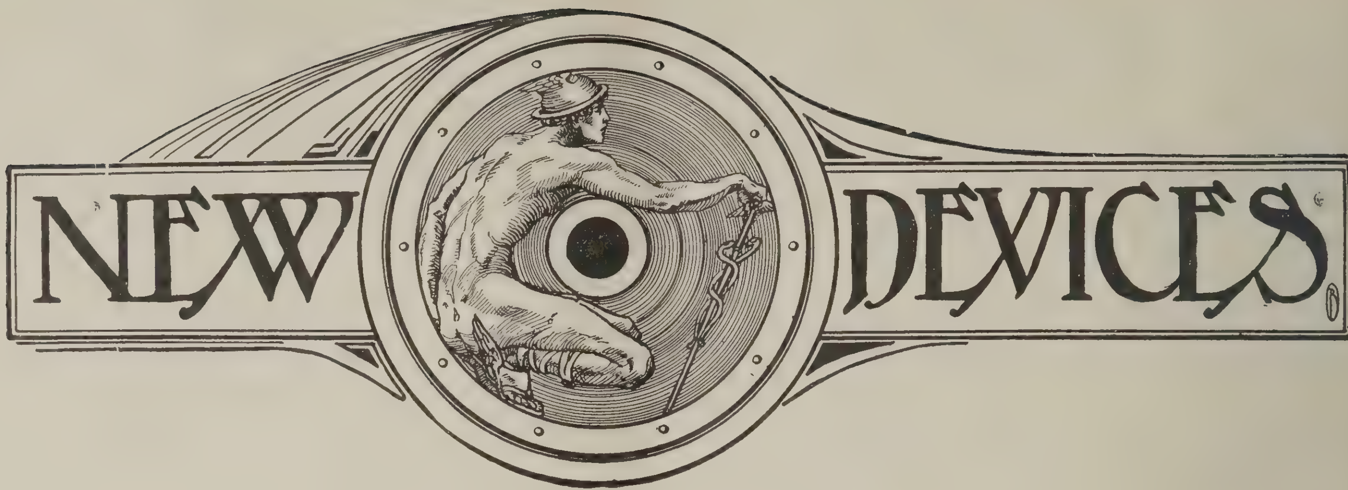
where x is the resistance in ohms between the bridge set and the ground and L is the loop resistance of the two conductors in the cable.

It will be seen from this, that it is also necessary to find the resistance of the loop before it is possible to locate the fault. This loop resistance may be found in exactly the same manner as any other unknown resistance would be determined as was shown in the Question Corner last month.

After having found the value of x from the formula, all that remains to do is to multiply this value by the number of feet of wire per ohm of resistance. Usually for telephone circuits, No. 22 gage wire is used and this wire runs approximately 60 ft. per ohm.

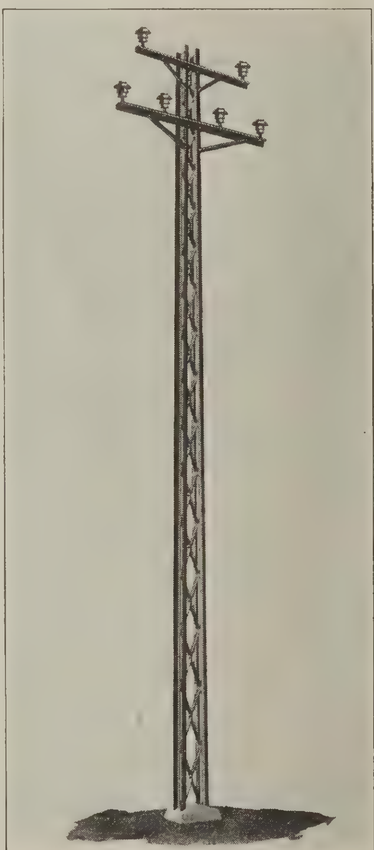
Questions for February

How can a slide wire type of Wheatstone bridge be made and how is such a bridge used in measuring resistance?



A New Steel Pole

The Truscon Steel Company, Youngstown, Ohio, has placed on the market a steel pole which is designed primarily to meet the demand for a metal pole that is strong, rigid, durable and economical in either light or heavy service. This pole can be used for electric transmission and distribution lines, telephone and telegraph lines, or any other purpose for which poles are needed. It is said that the cost is practically the same as that of a wood pole. The manufacturer subjected this pole to practical tests under varying conditions for a period of over two years before placing it on the market.



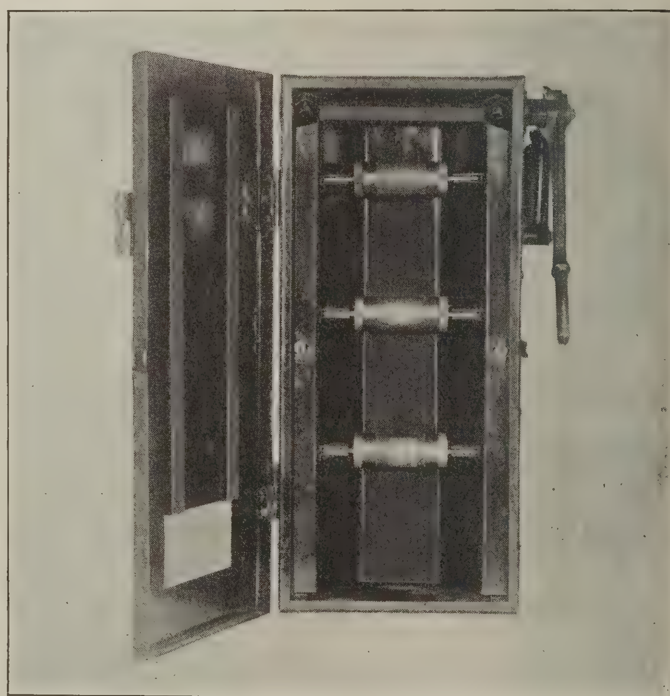
The Truscon Steel Pole

The salient feature of the pole is its simple construction. It is made from 5 in. to 12 in. steel channels or I-beams. The pole is manufactured by pressing a portion of the web of the channel, or I-beam, out to a predetermined angle and then riveting this pressed out section to a similar section of another channel or I-beam. So strenuous have been the tests given this pole that the manufacturers claim that when it is anchored in concrete and painted about every five years it will last indefinitely. It is manufactured in all sizes up to a length of 50 ft. and so constructed that no special equipment is required by linemen to climb it. This eliminates pole steps and the need for climbers.

A complete line of galvanized fittings has been designed for the pole, to fit any size of standard cross-arm of either wood or steel, these costing no more than ordinary through bolts. When more than ordinary strength or extra length are desired the pole can be made in combinations of two or more.

New Double-Break Safety Switch

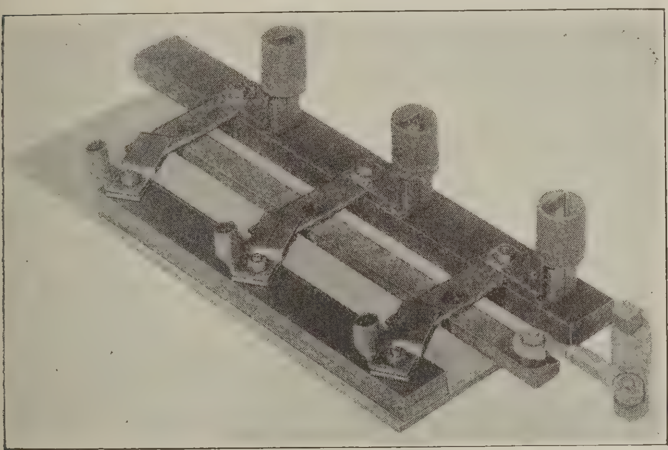
A new double break enclosed switch that has several new departures in safety switch construction, has been developed by the Super-Safety Electric Co., Chicago, Ill. One of the chief differences in design as compared with prevailing practice, is the arrangement of the switch controls on the side of the cabinet, instead of on the base as is normally the case. From one of the illustrations showing a half section of the contact members, it can be seen that an almost perfect and even contact between the fixed and



Complete Switch With Protective Shield and Fuses in Position

movable parts is secured by reason of the tandem layout of the switch blades. All three contacts on either side are secured to an insulating bar that produces a uniform make and break of all three contacts, and since the two bars (one on each side) are controlled by the same handle it follows that all six contacts open and close in step with each other.

All live current carrying parts are covered with an insulating shield in such a manner that the device is said to be absolutely safe regardless of whether the door is closed or open. This enclosed type of construction can be seen from the photograph showing the complete assembly with the protective shield and fuses in position. A feature of importance is the fact that the fuses are readily accessible and may be handled with entire safety. The cross bar is located at the end of the switch about one inch from the cover and does not interfere with the installation or



Assembly View of One Half of the Contact Members

removal of fuses. The design of the handle is such that a quick break and positive make are obtained at all times, without the heavy impact. The switch cannot be left in partial contact as it can only be left in the full "off" or full "on" position.

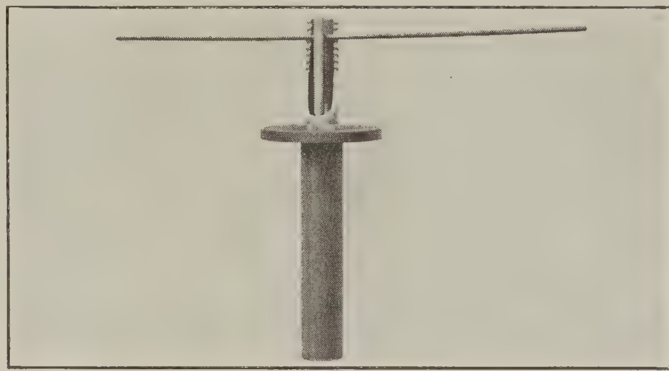
The double make and break construction permits bringing the line and load wires into the cabinet at either end, and in drawing cables into the cabinet no twisting or straining of cables is necessary as the lugs can be sweated onto the cables on the outside of the box and later attached to the contacts in the usual manner. All contact members are of one piece, solid copper; no bolted or soldered connections are used, except in the case of the wire lug connections.

Additional advantages claimed are: an increased wiring space within the switch, a greatly enlarged flashover distance between opposite polarities (particularly important in 600-volt circuits), extreme durability and a low maintenance cost.

Welding Electrode Holder

A new type of welding electrode holder marketed by the General Electric Company allows welding operators to make a quick change from burnt stub to new electrode. The operator needs only to strike the stub end of the old electrode, causing it to drop out, when the new wire can be inserted instantly without unnecessary effort.

The new holder consists of a punched fibre tube with a tinned brass plug inserted in the end. A steel spring rod holds the electrode in place against one of a number of different sized notches provided for the purpose. The welding cable running to the source of power is soldered to the other end of the holder by removing the fibre tube



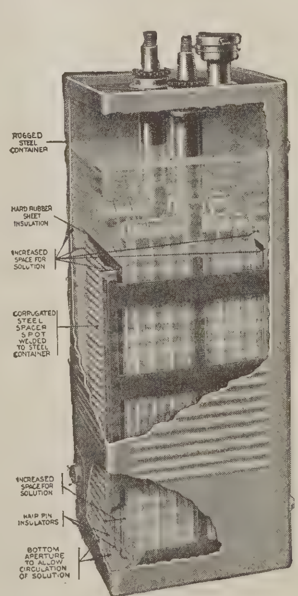
The Holder Will Accommodate All Sizes of Welding Electrodes

and fibre guard which is accomplished by loosening a single screw.

The construction of this holder is such that the contact of the electrode is not weakened by heat, since it does not depend upon a heat-affected spring.

Improved Edison Battery for Train Lighting

Several improvements have been added to the "HW" type of Edison carlighting battery which, it is expected, will provide the battery with many added years of life. The improvements consist essentially of 1, an increase in thickness of the steel container; 2, an improvement in the method of application of the insulating coating on the outside of the steel container; 3, a strengthened steel spacer for the interior steel plates, and 4, an improved type of insulator between the steel plates.



Skeleton View of Improved "HW" Cell

The new steel container is made of approximately 50 per cent thicker gage than the old style. The new method of applying the Esbalite coating causes the paint to adhere better to the metal of the container, thus effecting better insulation. The steel spacer has been increased in width so that instead of pressing against the center of the outside negative plate it now exerts equal support against the entire width of the negative plate. The new type of insulators is constructed of the same hard rubber material as formerly, but is of the hairpin type, bent under the positive and negative grades, making it impossible for them to become loosened or to get out of place.

General News Section

The car shops of the New York Central at East Buffalo, N. Y., are to be operated by the company beginning March 1. Since November, 1921, these shops have been operated by the Conners Car Company.

Shop employees of the Delaware, Lackawanna & Western have finally called off the strike which has been effective since July 1, 1922. The Lackawanna has issued a statement that the men will not be given their old jobs back but will have to apply for work as new men.

The Interstate Commerce Commission by an order dated January 12 has changed the date of fulfilment of its train control order as to the Delaware, Lackawanna & Western from January 1 to July 1, and has also specified the territory as between Elmira, N. Y., and East Buffalo, instead of between Hoboken and Buffalo.

The Chicago & Eastern Illinois has operated 14 years without killing a passenger. During that period the system has transported an average of 2,000,000 passengers yearly and each passenger has averaged 95 miles. The trains have covered 2,800,000 passenger train miles per year.

The Colorado Special of the Chicago & North Western operating between Omaha, Neb., and Chicago was robbed en route of parcel post shipments on January 5. The shipments were in sealed cars and it is thought the robbers had keys which fitted the locks and had time to open the parcel post packages before the train reached Chicago.

William G. McAdoo, formerly director general of railroads under the United States Railroad Administration, has been appointed a member of the mediation commission which will attempt to settle the dispute between the city of Los Angeles, Cal., and the railways entering that city with reference to the municipality's demand for a union passenger station.

The four special trains carrying guests of the Seaboard Air Line to the celebration of the opening of that Company's new line to West Palm Beach, Fla., were delayed by floods in Georgia and arrived at Sebring, Fla., on Sunday, January 25, about 24 hours late. The ceremonies were carried out on Sunday afternoon in front of the Kenilworth Inn at Sebring.

Electrification of the Long Island's Montauk division between Jamaica, Queens, New York City and Babylon, L. I., is progressing rapidly. Most of the third rail is in and portions of it have been made alive to provide current for installing bonds at joints of the running rails. All the substations are nearing completion and the transmission line is up except for a few short gaps.

The shares of stock in the New York Central Railroad recently offered by the company for sale to employees, to be paid for on the installment plan, were quickly subscribed for, the total number of subscriptions to January 23 being 35,000 shares. Not more than 20 shares were allotted to any one employee. The price, $110 a share, is to be paid in 21 monthly installments.

The 75th anniversary of the beginning of operation of the Chicago, Indianapolis & Louisville, was celebrated on January 13. The original company, the New Albany & Salem Railroad Company, was incorporated on July 8, 1847, to build a railroad between the points named in its title, a distance of 35 miles. Construction was begun in 1849 and the road completed and opened for traffic on January 13, 1850.

Employees of the Illinois Central and members of their families to the number of 3,500 from all points on the system, but principally from the general offices and the divisions adjacent to Chicago, attended a special performance at the Auditorium theatre, Chicago, given by the Chicago Civic Opera Company on Sunday evening, January 18. The entire house was reserved by the railway and the audience was confined to employees and their guests. The opera presented was "Aïda."

The Canadian National Railways has inaugurated a practice of publishing each month a small booklet giving in detail the numbers which may be heard from its various radio broadcasting stations and the exact hour which each will be on the air. The February radio program recently issued contains 36 pages and outlines the complete programs of the 9 big stations which are located at Moncton, Montreal, Ottawa, Toronto, Winnepeg, Regina, Saskatoon, Calgary and Edmonton.

The St. Louis-San Francisco has taken out $4,000,000 additional life insurance for its employees with the Metropolitan Life Insurance Company. The additional death and dismemberment insurance applies solely to supervisory employees who are entitled to individual protection ranging from $1,000 to $5,000, the schedule being the same as that included in the life insurance program affecting the same group of workers which became effective last year. The new insurance was written on the contributory basis and affects about 1,100 employees.

The Okonite Company opened an office at 310 South Michigan avenue, Chicago, on February 1, to take over the sale of Okonite products in the western territory. Charles E. Brown, vice-president of the Central Electric Company, has been appointed vice-president in charge of the territory west of Pittsburgh and east of the Rocky Mountains of the Okonite Company, with headquarters in Chicago. A. L. McNeill, manager of the railroad department of the Central Electric Company, has been appointed manager of the railroad department. E. H. McNeill, railroad sales representative of the Central Electric Company, has been appointed sales engineer. Roy N.

Baker, railroad sales representative of the Central Electric Company, has been appointed sales engineer. L. R. Mann, sales representative of the Central Electric Company, with headquarters at St. Louis, has been appointed manager of the St. Louis office. Joseph O'Brien, railroad sales representative of the Central Electric Company, has been appointed sales representative, with headquarters in Chicago, C. E. Brown, Jr., country sales manager of the Central Electric Company, has been appointed manager of the light and power department.

Brown Boveri & Co., Swiss Electrical Manufacturers, to Enter American Field

Brown Boveri & Co., the Swiss electrical manufacturing concern, which also has plants in many other countries, has decided to enter the American field, it was announced in New York on January 27. The company, it is said, will make an initial investment of from $35,000,000 to $40,000,000 for the purchase of six or eight manufacturing plants in various parts of the country—specifically, "on the Eastern seaboard from Boston to Chesapeake Bay, in the Middle West and on the Pacific Coast." Active operation is expected to start within 90 days. The company expects to manufacture a wide variety of electrical equipment, including electric locomotives. Preliminary negotiations are in the hands of Laurence Wilder, 225 West Fifty-seventh street, New York. The company's statement says:

"While American manufacturers have made great strides in the field of large scale production and in the standardization of machines and equipment of the more usual types, it may be fairly said Europe is far in advance of this country in the development and successful application of many electrical inventions which make for efficiency in operation and economy. These improvements have been long appreciated by the users of electrical equipment in both public utility and railroad fields, and there has been a strong desire and a great endeavor to obtain the benefit of these improved and original developments in this country."

In this connection the Buchli drive for locomotives and the mercury arc power rectifier were specifically mentioned. The statement continues:

"The Brown Boveri Company, whose main office and plant are in Switzerland, has a position in Europe quite as important as that of the General Electric Company in this country. It employs many thousands of operators, it has subsidiary plants in France, Germany and Italy, and it is not so many years ago that it took over and absorbed the European plants of the Westinghouse Electric Company of Pittsburgh. It has had for the last two years an agency in this country whose chief purpose has been to test out the American market for Brown Boveri products. They are in many fields of electrical operation quite unique, and have no substitute or counterpart.

"The significance of this move is not alone in the opportunity it gives to American consumers to obtain readily Brown Boveri products, but in the fact that they can be supplied at lower prices than now prevailing for similar products. In the relation of this fact to the various public services, such as light, power, and transportation, is seen at once a method to curb mounting costs of these services, and no more effective way may be found than in keen competitive development."

Electric Operation Will Be Started on the Detroit & Ironton About June 1

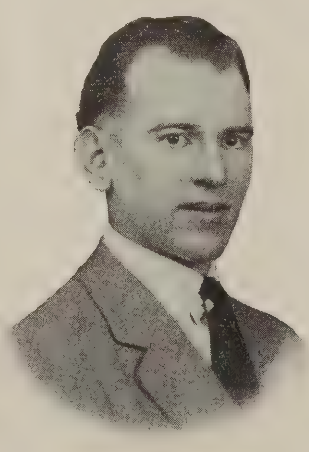
First tests of the Detroit & Ironton locomotives will take place on a section of track just outside the River Rouge Ford plant at Detroit, Mich. Foundations for trolley-support arches have been laid along three miles of this double-track line. Concrete parts for the trolley supports are being cast. Power for operating the road will be developed at 13,200 volts, 60-cycles, 3-phase alternating current. A frequency changer substation to be built near the power house will convert this energy to 22,000-volts, single-phase, 25-cycle alternating current power for use on the trolley. The truck and trolley are expected to be in condition for tests about June 1.

Three of the four sections of the first locomotive have been practically completed. The main wiring on the first section has been completed and the control wire is being installed. The main wiring has also been partially completed on the second and third sections. Flexible armored cable is being used for all main circuit connections. This is a wiring feature which has probably never before been used in an electric locomotive. All of the main direct current leads are covered with steel armor, while the alternating current leads are covered with brass armor. It is expected that the locomotive will be completed and ready for tests some time during April.

Personals

Carl A. Pinyerd, representative of the Safety Car Heating & Lighting Co., at Chicago, has been appointed district engineer in charge of engineering and service matters, with headquarters at Chicago.

W. C. Marshall has been recently appointed to the position of train lighting maintainer of the Chicago, Milwaukee & St. Paul Railway with headquarters at Milwaukee, Wis.



W. C. Marshall

Mr. Marshall was born December 23, 1891, at Marion, Iowa. He attended the public schools and high school of Marion and also of Missoula, Montana. During the years of 1909 to 1911, he was a student at the University of Montana. Between 1913 and 1916, Mr. Marshall was assistant operator and operator for the Montana Power Company. In 1916 and from then until his recent appointment, he was engaged on the Chicago, Milwaukee & St. Paul road, successively, as electrician, armature winder, foreman of substation maintenance on the Rocky Mountain division, electric locomotive engineer instructor and assistant electric foreman at the Tacoma shops, Tacoma, Washington.

During the summer of 1924, Mr. Marshall acted in the

capacity of lecturer on the exhibition tour with the bipolar type of electric locomotive through the eastern states.

L. C. Hensel, formerly electrical engineer of the St. Louis-San Francisco has been appointed chief electrician of the Chicago & Alton, with headquarters at Bloomington, Ill., succeeding S. W. Dietrich, resigned. Mr. Hensel was born December 12, 1878, at Port Jervis, N. Y., and was educated in the high school at Hawley, Pa., and the Wyoming Seminary, Kingston, Pa. He was construction electrician during 1901 and 1902 with the Lackawanna Steel Company, at Buffalo, N. Y. He first entered railway service as an electrical foreman on the Frisco on July 7, 1903, and was made electrical engineer in 1908. From July, 1917, to May, 1918, Mr. Hensel was plant superintendent for the Gould Storage Battery Company at Depew, N. Y., on the building of submarine storage batteries. He returned to the Frisco in May, 1918, as electrical engineer and remained in this position until his resignation on May 5, 1924. He was appointed chief electrician of the Chicago & Alton, as noted above, on January 7, 1925.

L. C. Hensel

H. S. Peck, train lighting maintainer of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., has been promoted to supervisor of locomotive and power plant operation, with headquarters at Chicago, a newly created position. Mr. Peck was born on March 27, 1889, at Roy, Mont., graduating from Montana State College in electrical engineering in 1911. He entered railway service as a draftsman, inspector and designer in the electrification department of the Chicago, Milwaukee & St. Paul, in which position he remained until the fall of 1917, when he entered the United States Army, serving in France on the technical staff of Chief of Engineers of A. E. F. Department of Construction and Forestry, until July, 1919. Mr. Peck re-entered railway service in the office of the general superintendent of motive power of the Chicago, Milwaukee & St. Paul, being appointed train lighting maintainer on January 1, 1924, which position he held until his recent promotion to supervisor of locomotive and power plant operation.

H. S. Peck

David B. Rushmore, one of the consulting engineers of the General Electric Company, has resigned his position, and will be located in New York City, with headquarters at the University Club. His resignation followed orders from his physician to take a long rest and avoid desk work. Mr. Rushmore has served 25 years with the General Electric Company and with the Stanley Electric Company of Pittsfield, which was absorbed by the General Electric Company. He went to Schenectady in 1905, and for 17 years was engineer of the power and mining department. Since 1922 he has been one of the consulting engineers. Previous to his service with the General Electric Company, Mr. Rushmore was with the Westinghouse Electric and Manufacturing Company, and later with the Royal Electric Company of Montreal. He was graduated from Swarthmore College in 1894 with the degree of bachelor of science and engineering, and from Cornell University in the following year in the electrical engineering course. In 1897 he received the degree of civil engineer from Swarthmore, and in 1923 the honorary degree of doctor of science from there. Mr. Rushmore is a member of numerous American and European engineering and technical societies, and of Schenectady and New York clubs.

Trade Publications

Sangamo Electric Company, Springfield, Illinois, has just issued its parts list No. 9, entitled, "Price list of repair parts for Sangamo type H watt-hour meters."

Roller Smith Company, New York, in its bulletin No. 530, illustrates and describes a new double-pole interlocked trip circuit breaker and a new shock proof circuit breaker.

Reinforced Switch & Manufacturing Company, Pittsburgh, Pa., is distributing an illustrated envelope folder showing the application of steel spring reinforcement to fuse clips.

The Martindale Electric Company, of Cleveland, Ohio, has recently issued a four-page illustrated bulletin, showing the application of a small hand blower developed by the company. The device is known as the Imperial Blower-Clean.

"Electric Circuit Breakers" is the title of the small booklet recently issued by George Ellison of Birmingham, England. The booklet points out the reasons why the circuit breakers are essential for most circuits, and for the protection of motors.

Vertical Alternators is the subject treated in bulletin No. 840 just issued by the Electric Machinery Manufacturing Company of Indianapolis. The characteristics of this type of generators are pointed out and several typical installations are illustrated.

A ninety-six page catalogue has just been published by the Chicago Fuse Manufacturing Company of Chicago. It contains information useful to those interested in electrical products. Many different kinds of fuses are illustrated as well as a variety of conduit boxes and conduit fittings.

Railway Electrical Engineer

Volume 16 MARCH, 1925 No. 3

Yard Lighting with Low Mounted Flood Lights

The subject of yard lighting is one which must necessarily engage the attention of electrical engineers on all railroads. There is a decided tendency to improve the lighting facilities of railroad yards to a degree where it will be practicable to carry on work at night with the same efficiency as is possible in the daylight hours. The flood light system of illumination is constantly being installed, and even though there are many opponents to this type of lighting, the installations that have been made seem to be giving entire satisfaction to the railroads that are using them.

Apparently, there is much to be learned in the planning of yard lighting. Many of the layouts devised use poles of extreme height—70-foot poles being quite common, while towers considerably higher than these are sometimes used. Undoubtedly, there are occasions where extreme high mounting of flood lights is desirable, but there is also something to be said regarding the relatively low mounting of such units.

In another part of this issue is an article describing the illumination of coach yards by means of flood light lamps. It is significant that with the exception of a few units mounted on a coal chute, the lamps are placed only 35 ft. above the ground. It is true that these lamps are not banked, but are used singly, one unit on each pole; in other words, the lighting is distributed. The fact remains, however, that the installation is giving complete satisfaction, and although the location of the flood lamp is comparatively low, there has been little or no complaint of objectionable glare. It is not to be expected that this or any other system of flood lighting as applied to railroad yards will meet with the approval of everyone or will be suitable to all conditions, but certain it is that each new installation affords additional experience and carries us that much further toward the ultimate solution.

Cause and Effect

Electrically operated trains appeal to the popular taste for reasons that are not unusually those which cause their adoption. The average man, when electrification is proposed for the line on which he rides, sees in it faster and more frequent service, cleaner trains, the elimination of the smoke nuisance in large cities, etc. There is also an element of glamour and mystery about anything that is operated by electricity. The average railroad operator sees in it a method for relieving congestion in certain territories. He also sees in it a radical change in present conditions of operation with which he is familiar, and he does not relish the thought of taking the trouble to learn new tricks.

In most cases in the past, the adoption of electric traction has also required the development of an electric power generating system to supply the necessary electrical energy. This superimposed a relatively large power plant organization on the railroad organization with some attendant complications. The conditions are changing as the facilities for the purchase of power increase. Power lines are being extended and interconnected so that continuity of service is assured. The Department of Commerce is aiding this movement and state governments are endeavoring to make satisfactory arrangements for the transmission of power across state boundaries. Great interconnected power systems already exist in the south and the west. With this kind of power supply, the railroad problem is simplified and becomes essentially the substitution of one kind of motive power for another.

On the other hand, a great popular appeal for electrification is being fostered. Newspapers are more than willing to print a story on electrification because of its appeal to the popular fancy. When the subject is introduced at club and society meetings, an overflow meeting is almost sure to result. A rumor that a certain suburban line is about to electrify causes the prices of real estate along that line to rise. State and federal activities, relating to the subject, stimulate the popular interest. With the public asking for it generally and with real need for it existing in many places, it would seem that more widely extended adoption of electric traction in the near future is inevitable.

The St. Paul Electrification Report

The Chicago, Milwaukee & St. Paul electrification report, published elsewhere in this issue, shows that the two electrified sections on that road have effected savings over steam operation amounting to from $671,014 to $1,928,626 a year. This report should boost railroad electrification. The figures given in the report, beyond any doubt, are accurate. It is only to be regretted that the methods for arriving at these figures are not explained more fully.

Without a complete explanation of the methods employed, the report is open to criticism by the advocates of steam locomotives. For example: the report states, "The cost of steam operations for the year 1923, had this form of operation been employed on these electrified sections, is based upon the actual cost of steam operation for the last twelve months such operation was in effect, adjusted to the costs obtained in 1923. The last year of steam operation in the case of the section Harlowton to Avery was the year ending December 31, 1915, and for the sec-

tion Othello to Tacoma, August 1, 1918, to July 31, 1919."

In order to compare properly results it is, of course, necessary to adjust the costs. Unfortunately, the report does not state whether or not improvements in steam locomotives have been taken into consideration. One of the largest savings shown is due to the reduced cost of electric power as compared with coal for steam locomotives. Steam locomotives used on the St. Paul in 1915 were not as efficient as those of modern design, and unless an adjustment for this difference was made in the report, the savings shown are greater than would be the case if modern steam power were used in place of electric. The cost of operation was reduced by electric power, but it also might have been reduced to some extent by modernizing the steam power.

To be sure, this additional adjustment would probably not greatly effect the results shown. They are correct qualitatively, if not quantitatively, for comparing modern steam with electric power. If a railroad like the St. Paul with long hauls and relatively light traffic can show such remarkable savings by electrifying, it is high time that many other roads with more congested sections for which electrification has been considered for years, exchanged steam power for electric.

Some Splendid Opportunities

Among the new things which are being adopted by the railroads are train control, self-propelled cars, radio as applied to moving trains, and electric welding. How this equipment shall be purchased and how it shall be maintained has not yet been definitely established on most roads. Most of the train control apparatus which requires any considerable maintenance is on the locomotive, and with the exception of two systems this apparatus is largely electrical. Straight electric and gas-electric cars are essentially electrical problems. A straight gas car would appear to be something purely mechanical, but it should be borne in mind that about half the maintenance work on an automobile, not including tires, is electrical work. Furthermore, a straight gas car requires a more elaborate lighting system than an automobile.

Radio on moving trains is a form of communication and might seem to come under the telegraph and telephone department. At present, however, it is essentially a one-way transmission, and has nothing to do with the transmission of train orders or messages; it is installed on the car and is something with which most of the electrical men are quite familiar. Welding is essentially a mechanical problem and the work is gradually becoming standardized, but it must not be forgotten that electric welding requires electric power service and that it is fundamentally a cheaper process than any other. Furthermore, it is up to the railroad electrical man to further the cause of electric welding. Gas welding provides a constant revenue to the manufacturer through the sale of gas, and he can therefore afford to spend time and money for increasing the use of his product on the railroads. The manufacturer who sells electric welding machinery to the railroads derives no profit from the sale of electric power, and is therefore not in a good position to further the use of his machinery after he has sold it.

Obviously, the best way for anyone to get into these new border line activities and have jurisdiction over them is to know more about the subject than anyone else on the road. Association activity is probably the best means to this end. The Association of Railway Electrical Engineers has active committees at work on these subjects, and it is the only association of railroad electrical men which interests itself in such activities. Are you a member, and are you taking a part in its activities along these lines?

New Books

Switch gear for electric power control by E. Basil Wedmore and Henry Trencham, 335 pages, illustrated, diagrams and tables, 5½ in. by 8¼ in. Bound in cloth. Published by Oxford University Press, American branch, New York. Price $8.35.

The book contains much about the design of control apparatus written from the user's point of view, which the student and drafstman frequently have difficulty in obtaining from other sources. The subject of motor starting and rheostat design are not dealt with and the important new subject on automatic station work is only briefly touched upon. The book contains 30 chapters. Beginning with fuse cutouts, the subject matter proceeds with various kinds of circuit breakers, switch protective devices and methods. Although the author states that the book makes no pretense of being a treatise, it is nevertheless true that it does contain a very large amount of information upon the subject indicated by the title.

Telegraphy and Telephony with Railroad Applications by Charles Stanley Rhodes, formerly telegraph and telephone engineer, New York Central lines; 486 *pages, illustrations and diagrams, 4½ in. by 7 in. Bound in cloth. Published by the Simmons-Boardman Publishing Company,* 30 *Church Street, New York City. Price* $3.00.

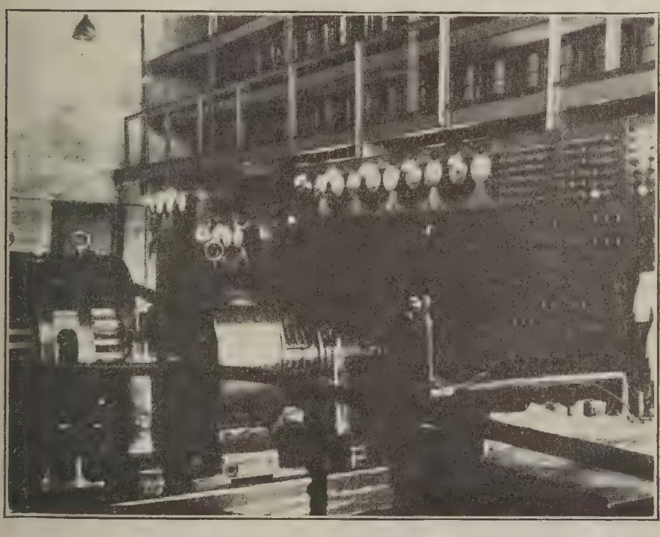
While the fundamental principles of telegraphy and telephony are alike for both commercial and railroad service, from a large number of investigations made during the years of his experience in the railroad field, the author has produced considerable original information which is included in his new book. Those practices of the railroads which differ from commercial telegraph and telephone work, as well as the most recent developments in railroad telegraphy and telephony make the book of special value and one which will be frequently used for reference. It gives the reasons for established practices and states the procedure to be followed in doing any particular job. The arrangement of the subject matter that would seem logical for a book intended to be helpful to beginners, as well as to experienced workers, has been carried out by the author. By presenting first a description of the railroad telegraph and telephone plant and then giving a short outline of the organization responsible for its construction, maintenance and operation, the reader is ready for a study of the fundamentals of electricity and magnetism. This information, although elementary, is essential to a clear understanding of many of the details and practices that are explained. Pole line construction, the proper selection of kinds and sizes of line wire, operating characteristics of open wire lines, cable construction, specifications and splicing methods, are problems of outside plant construction and engineering that are covered in the book. There are also to be found many details of practices covering the inside plant. Protectors and their function in their telegraph and telephone work, a description of the Gill selector, the principle of telegraph repeaters, and the description of many other operating practices as well as a plant equipment constitute the major portion of the book. An appendix contains several tables on pole data and pole line loading for various conditions.

Union Depot, Washington, D. C.

Car Lighting Practice at Washington Terminal

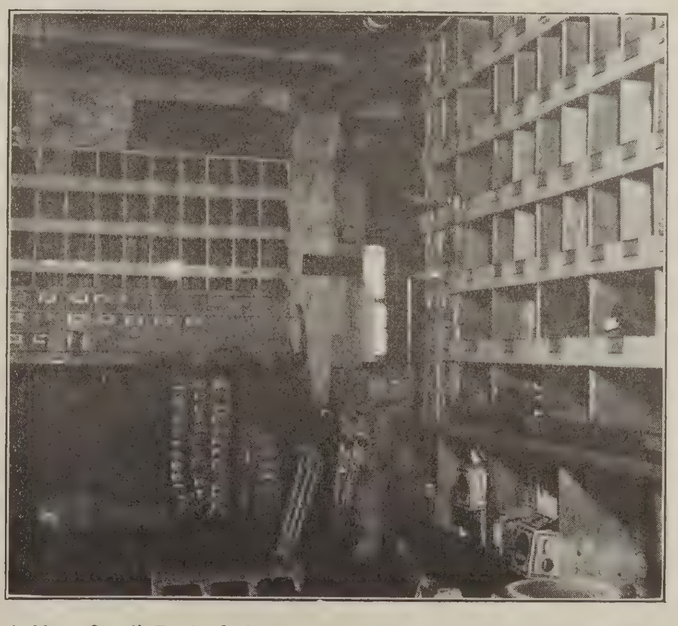
Methods in Vogue Where Twenty-eight Different Types of Equipment Call for Inspection and Maintenance

AT the nation's capital it is only natural that many railways should converge, and at Washington the truth of this statement is fully demonstrated. The roads which make use of the Union Terminal at Washington, D. C. are the Baltimore & Ohio; the Chesapeake & Ohio; the Pennsylvania; the Richmond, Fredericksburg & Potomac; the Southern Railway. These are the big lines, but in addition, cars are delivered by them through the terminal to the Atlantic Coast Line and the Seaboard Air Line; Florida East Coast; the Louisville & Nashville and the Norfolk & Western. Even the New Haven cars and those of the Canadian National Railways, as well as the Boston & Maine; the Maine Central and the New York Central find their way over other lines to the Washington Terminal.



A Corner in the Charging Plant, Showing the Large Synchronous Motor in the Foreground and the Operator's Desk at the Extreme Right

Altogether there are between 450 and 500 cars which require daily inspection from the car lighting forces in the Washington Terminal. It is not surprising then, that the car lighting department at Washington is very busy in looking after the maintenance work.

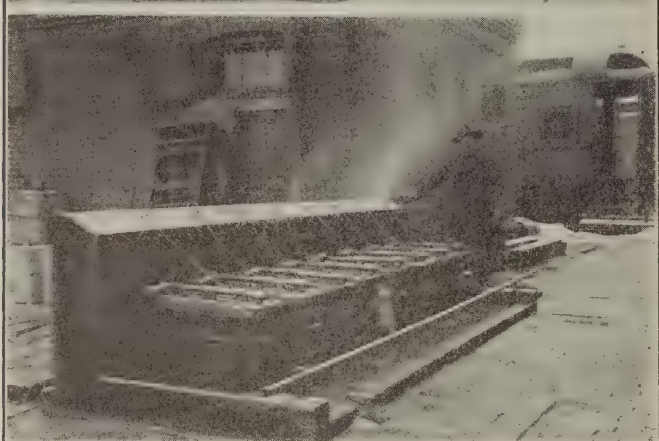


A Very Small Part of the Large Store Room Where Hundreds of Parts Are Carried to Supply the Requirements of Twenty-eight Different Types of Car Lighting Equipment

Owing to the fact that the station is some distance

away from the battery house and charging plant, one sees very few of the men at any one time as they are scattered about the cars and tracks in the station. All told, there are 7 different yards where car lighting men are at work one time or another.

The inspection work, which must be performed on so many cars daily, is obviously the big end of the work, although provisions are made in the battery house for handling both lead and Edison batteries. In the same building in which the battery house is located is situated the largest of four charging plants. This plant has been in service for a number of years, and while most of the equipment is somewhat different from that installed in the more recent plants, the equipment renders excellent



Upper—Steam Rack for Melting Petrolyte Between Lead Tanks and Wood Trays. Steam Covers Shown in Raised Position. Lower—Rack with Covers Lowered Over Top of Trays.

service and gives entire satisfaction. The charging machines consist of two, 50-kw. generators driven by 2,200-volt motors and one synchronous motor driving a 100-kw. generator. All three of the machines generate current at 110 volts. The load of this plant varies from 400 to 1,200 amp., the peaks coming at about 2 a. m. and 2 p. m. At peak loads the synchronous motor is run together with one of the 50-kw. sets, but for the greater part of the time the synchronous motor is operated alone.

The switchboard panels are equipped with 156 outlets to individual charging receptacles in the various yards and 12 outlets are fed directly to the battery house. The amount of current flowing from the board to any one of the outlets is determined by the switchboard operator, who is in constant attendance. As the charging proceeds both day and night there are three switchboard operators. employed, each working an 8-hour shift. It is the duty of these operators to handle all telephone communications relative to car operation as well as to operate the switchboard. In addition to this they also keep the record of

Using Compressed Air for Straightening Plates in the Process of Overhauling Batteries

current furnished to cars on charge. In effect these men act as a sort of central for handling telephone communications from all parts of the yard, such as reports of defective cars and records of cars in and out of service. The operators also act in a clerical capacity, as they write

Smoothing Down the Petrolyte on the Top of the Batteries After Plates and Covers Have Been Restored

up the daily reports of the several railroads using the terminal.

Power for the operation of this charging plant is derived from the main power station located near the passenger station. Energy is fed by means of underground conductors at 2,200 volts and used directly at this voltage without stepping it down. The lighting of the charging

room as well as that of the remainder of the plant is from a 110-volt circuit fed from another feeder.

The Daily Routine

The daily practice in regard to the inspection work is to make an inbound light inspection at the passenger

Left—Pouring Molten Lead Into the Mold in the Process of Making Terminals on the Battery Connectors. Right—Inspecting the Terminals After the Mold Has Been Opened

station for the purpose of determining the condition of the equipment before the cars are dispatched to the yard. This method expedites the handling of the work. When

Lead Burner at Work Building Up New Posts on the Plate Straps

the cars arrive at the coach yard the regular daily inspection is made of generator equipment. This work is performed by men classed as making regular daily inspections. They also make light running repairs such as repairing belts, applying pole changer leads, applying generator brushes, adjusting automatic switch contacts or

Cutting the Heavy Cable Used for Battery Conductors. The Cable Is Fed Through a Hole in the Table from a Large Reel Underneath and Cut Off with the Heavy Cutting Bar Device Especially Designed for This Purpose

brushes, or any other similar work. If, however, the work is of a heavier nature such as replacing armatures or field coils, the matter is reported to the gang foreman and he in

Armature Winders at Work in Winding Department

turn assigns a repairman. If the incoming inspection indicates that the batteries are in need of charging and the generator equipment is inoperative, the electrician at the passenger station immediately notifies the switchboard operator at the charging plant. He in turn reports the

case to the gang foreman who personally follows up the defective equipment.

It is also the duty of the men making regular daily inspection to report such cars as are due for overhauling. The man who is regularly assigned to do this work is dispatched to the car and the overhauling is done. If the car is found to be ready for battery inspection or flushing, this work is performed by other men who are assigned to this particular job. If the battery inspector finds that the battery is in a defective condition, a set that has been repaired or overhauled is applied to the car. The old set which has been removed, is taken to the battery house where it is taken down and rebuilt. This applies to lead batteries of all types.

If Edison batteries are found to lack capacity they are put through a rejuvenating test. This test consists of putting the set of batteries through four cycles of charge and discharge. Afer putting the batteries through these charging and discharging cycles they should come up to capacity. If there are any defective cells they are taken out and returned to the Edison Company for inspection and repair.

When capacity tests are being made on either lead or Edison batteries, half-hour voltmeter and ammeter readings are taken and recorded.

Work at the Battery House

In the battery house work of overhauling batteries is done. The batteries are moved from the cars and placed on the wash bench which is located in one end of the battery house. The old leads are cut off from the cells with bolt cutters and the petrolite is removed from the covers. The covers are then cleaned and those not defective are held for replacement. The elements are removed from the trays and placed on the bench where they are washed off. If any corrosion is found due to short circuits, it is carefully removed. The groups of plates, after being removed from the trays, are placed under a press operated by air pressure where all the plates are straightened out. The trays themselves are washed out and set aside for inspection. The removal of the lead tanks from the trays is facilitated by means of an arrangement which may be called a steam rack. This device consists of a number of covers fitted with steam pipes and hinged so that they can be swung down over the top of the trays containing the lead tanks. When in this position the steam is allowed to flow into the pipes and the heating which follows quickly loosens the petrolite from the sides of the tanks and they are easily removed from the trays.

After the tanks have been removed from the trays they are carefully inspected and those which are still considered as serviceable are placed in the battery house for future use. Some of these tanks which require only a small amount of repair are patched and painted and otherwise put into serviceable condition.

In reassembling the tanks again they are sunk into the trays with a mixture of paraffin and petrolite. This mixture is heated in a large kettle designed for the purpose, and when sufficiently hot, is poured into the double compartment of the wood trays. The tanks are then inserted into the trays. In order to hold the tanks down against the buoyancy of the liquid compound, wood forms are placed inside of the tanks and these are held down by means of levers until the compound cools. After this operation the trays are laid on the side and other petrolite compound is poured around the edge of the covered frame adjacent to the top of the wooden tray for the purpose of preventing acid seeping down between the tank and the tray. These trays are then ready to receive the elements.

Care of the Battery Elements

After the plates or elements have been straightened in the press they are turned over to the lead burner who cuts off the old posts or terminals and replaces these terminals by the use of a mold and the oxyhydrogen flame.

The steel mold is first placed over the stub of the old post and the flame allowed to play into the hole until the end of the stub is in a fluid condition, at which time molten lead is poured into the top of the mold. This molten mass solidifies very quickly and a new post is thus formed. After a number of these posts have been put on in this manner they are tested for strength by subjecting them to severe bending with a pair of heavy pliers. If they are able to withstand this test it is reasonably certain that they will not fail in service.

If it is found necessary to repair any of the groups such as burning on a plate to the strap or removing a defective plate and applying a reclaimed plate, this work is done at this time.

After these elements have been restored to first class condition by these various methods they are assembled in positive and negative groups, separators replaced and then inserted into the tanks. The covers are then applied and the petrolite compound poured around the covers, sealing them in.

After this has been done the finishing touch is performed with the use of a heavy iron 1 in. by 2½ in. in width and 4 or 5 ft. long. One end of this iron is placed in a forge fire and heated until it is red hot, and in this condition is applied to the petrolite compound, smoothing out all irregularities on the cover frames and sides of the trays, thus making a smooth finish and a tight joint between the cover frame and the cover.

The batteries are then ready for the electrolyte. The electrolyte is taken from the carboys and placed in a receiving tank in one corner of the battery house, and from this tank it is run out by gravity through a rubber hose into the various battery tanks.

Application of New Leads

It is next necessary to put on new battery leads. These are made all of No. 2 conductor and consist of 91 strands of rubber insulated wire. The type of terminal used is what is known as the mushroom type and it is molded to the ends of the leads by the lead burner. In making up these connectors it is very important to do it in the right manner, as otherwise the terminal will not adhere to the wire and a loose connection and possibly an exploded battery will be the result. The process used at the Washington Terminal and one which is most satisfactory consists of preparing the leads in the following manner. The rubber insulation is cut from about ⅝ in. The end of the wire thus exposed is then dipped into very hot solder which allows a very thin coat of tin to adhere to the wires. After the lead has been so coated the solder in the pot is allowed to cool somewhat and the lead is again dipped into it. At this temperature the solder is sufficiently hot to adhere to the first coating of tin, and forms a consider-

ably heavier mass than the first time it was dipped. With this heavy coating of solder on the end of the wire the lead is inserted in a special mold and molten lead poured in to form the terminal. By carefully following the two steps of doing this work it has been found that the molded terminal will not come off the wire under any circumstances.

After the connectors have been made in the manner described they are placed on the battery posts and burned fast with the oxyhydrogen flame. The batteries are then given a coat of acid resisting paint and placed on charge.

For the purpose of keeping records of overhauling periods, lead plates are molded in a special mold designed for that purpose. These plates are screwed fast to the front of the trays. They are made from lead which has been salvaged from old tanks as are also the new terminal posts which have been applied to the elements and the mushroom terminals just mentioned in connection with the new leads.

The Pit Motor

Cars which are reported in trouble and on which the regular daily inspection does not develop the nature of the trouble, it is found necessary to place on a special track over a pit which contains a motor for making special tests. A running test is made with the entire equipment. This motor is a variable speed machine and the controller is so designed that the generator can be operated in either direction. It can be started at low speed and gradually built up to high speed under such conditions as are met with on the road. In this way automatic switches and regulators are set and problems are worked out, as it is possible to develop difficulties which do not exist after the usual car inspection.

Winding Facilities

The terminal also provides winding facilities for the winding of headlight generators, shop motor armatures, transformers and car lighting generators.

Welding with Flux-Coated Electrodes*

Better Welding, Increased Speed and Reduced Labor Costs Make Fluxed Electrodes Inexpensive

By C. J. Holslag

It is a well-known fact that high temperatures are invariably favorable to a chemical reaction. Consequently the temperature generated by the electric arc, which will melt refractory metals with ease in an instant, and is the highest temperature than can be produced,

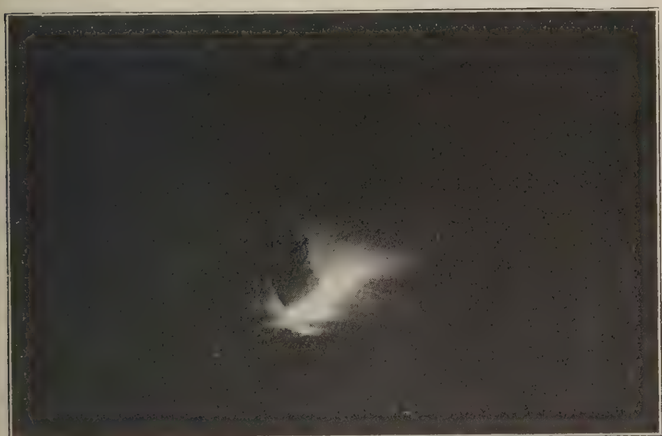


Fig. 1—English Type, or Slag-Coated Electrode

would naturally greatly encourage any tendency towards a chemical reaction. The first reaction is the universal chemical reaction—oxidation, and it will occur readily if the melting process takes place in air or anywhere in the presence of oxygen. There are many other chemical and physical changes due to the arc, such as the formation of compounds of carbon and nitrogen, furthered by the high temperature of the arc, and are undesirable in the completed arc deposit. The problem, therefore, that confronts the welding operation, or any process in which the melting of metal is concerned, is to prevent as far as possible the partial combination of the molten metal with oxygen and nitrogen; in other words, to avoid the formation of metallic oxides and nitrides. These compounds are, in general, very detrimental to the success of welding or casting, because they form inert, impervious and brittle mass which are liable to become entrapped in the weld, creating weak and imperfect sections. Therefore, any agent which will act to prevent their formation in the melting and welding of metal is highly desirable. The greatest of these aids is found in the use of the various kinds of fluxes.

The chief problem is, primarily, to shield the molten

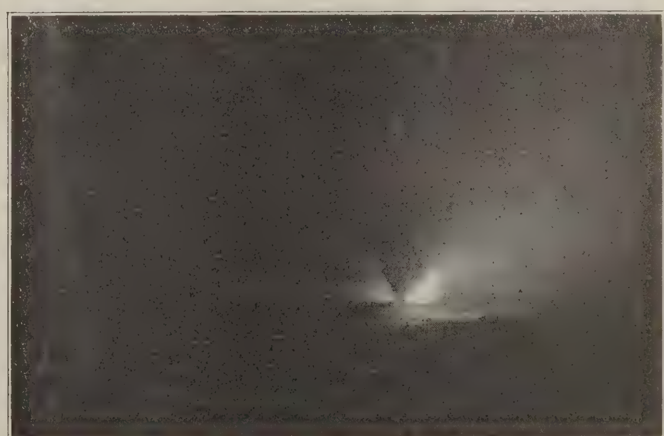


Fig. 2—American Type, or Flux-Coated Electrode

metal as far as possible from contact with the air, and then to dispose of whatever oxides or nitrides have unavoidably formed. If the proper fluxes are chosen, both these conditions may be thoroughly realized. If it is possible to surround the active weld with an inert mass that

* Paper read before the Chicago Section of the American Welding Society.

will melt at the temperature of the arc but will not combine with the air, the molten metal will then be prevented from coming in contact with the air, and oxidation will be greatly reduced. This is actually the condition realized in the use of the slag-coated electrode. This special electrode has a coating of such thickness and quantity as to melt at a steady rate with the melting of the electrode tip, and to form an envelope at all times about the arc and the molten puddle. A coating such as this may be of slag, asbestos or various silicates, in short, any material that may be used as a coating and will not combine with oxygen. The drawback to this type of coating is that the slag is liable to become entrapped in the weld and in protecting the deposit from microscopic impurities actual deposits of slag may be found in the weld.

Besides this type of dead, inert coating, the electrode may be coated with fluxes which are chemically active in a favorable way. These are valuable in other duties besides the all-important prevention of oxides and oxidation and they may be chosen to combine with and eliminate various undesirable elements in the welded metal itself or they may be effective in producing any desirable chemical composition in the deposited metal, or they may, as in soldering, act to clean the welding surfaces from dirt, grease or oxide. All these actions are, of course, favored by the heat of the arc, and may be combined in one coating of flux. It is well known, when welding with bare wire of any ferrous composition whatever, that the resultant weld is composed of pure iron, because the high temperature of the arc drives off the other ingredients as gases. It is the function of the flux to prevent this state of affairs, and it does prevent it in a most effective way. As a matter of fact, modern developments in flux coatings have made it possible to lay down deposited metal of a *predetermined composition,* so that it is now possible to duplicate in the weld such metals as manganese steel,

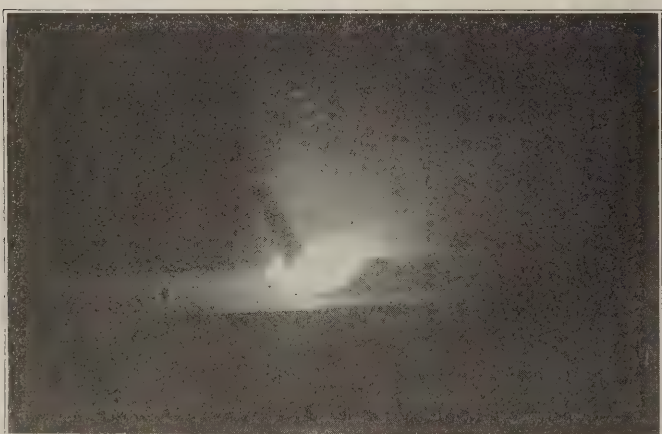


Fig. 3—Bare Wire Welding

high-carbon steel, and other steels of very special qualities impossible to deposit with the bare wire electrode, no matter what its composition. These chemically cleansing fluxed rods leave no slag that has to be chipped off, while the inert covered type leaves a heavy slag, and even bare wire leaves a thin but very tenacious slag.

The quality obtainable with the use of the flux coated electrodes make them more economical than those of bare wire. In no way is it possible with bare wire to make an arc weld possess any ductility or elongation. But with the flux coated electrode, it is possible to duplicate all the physical properties of cast steel—ductility, elongation, tensile strength, alternating stress, etc. In fact, tests made by the Interborough Lines of New York City in 1918 before a committee composed of Interborough engineers, engineers of the Public Service Commission, and of the City of New York, resulted in the verdict that such an electrode deposit possessed all the properties of good cast steel.

Likewise in August, 1919, the Wirt-Jones tests showed that the properties of ductility and elongation were increased by fluxed electrodes as a result of the cold-bend test, and at no sacrifice to strength, because in each case

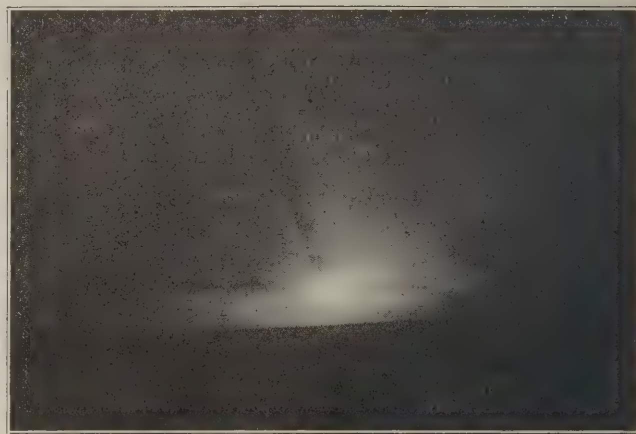


Fig. 4—Bare Wire Welding

the test piece broke outside the weld. With no other system was this true in those tests.

Fluxes are also useful in ridding the weld of such undesirable impurities as sulphur and phosphorous, both of which tend to produce a hard, brittle mass of metal in a weld. It is a fact to add that all desirable impurities such as manganese and carbon burn out of the weld easily while sulphur and phosphorous persist. This type of flux is usually composed largely of silicates, which readily combine with impurities and which, in addition, possess the advantage of forming the already-mentioned inert envelope about the arc. Moreover, the use of this flux requires no special preparation, and a rod with this coating is deposited with only the usual care required in welding. Furthermore flux-coated electrodes deposit faster for the same current because of the greater voltage across the arc caused by the coating.

In cast iron welding, a great modern development of the arc, the use of the flux is almost indispensable; in fact most of the improvements in cast iron welding have been due to the use of fluxed electrodes. This type of flux either unites with the excess of carbon in the cast iron, or tends to keep the hard carbon-iron compounds from forming. It is composed of a compound rich in carbon together with lime or other carbonide compound which becomes active under the heat of the arc and resupplies the free carbon which tends to keep the weld soft. In addition to this, the flux may contain nickel, silicon, manganese, or other compounds which prevent oxidation, tend to keep the weld molten, and bring about other desirable results. The flux coated steel electrode is of great assistance in all studding work, and any other work of a kind in which special conditions have to be met. A specially developed flux makes possible the use of an electrode actually made of cast iron. This flux provides for a quieting reagent, rapid floating of dross to the surface, absorp-

tion of oxygen or nitrogen, and a protection against rapid surface cooling. This is the highest development of which a flux is capable at present, and makes possible a weld with the iron electrode which possesses all the qualities of the original cast iron.

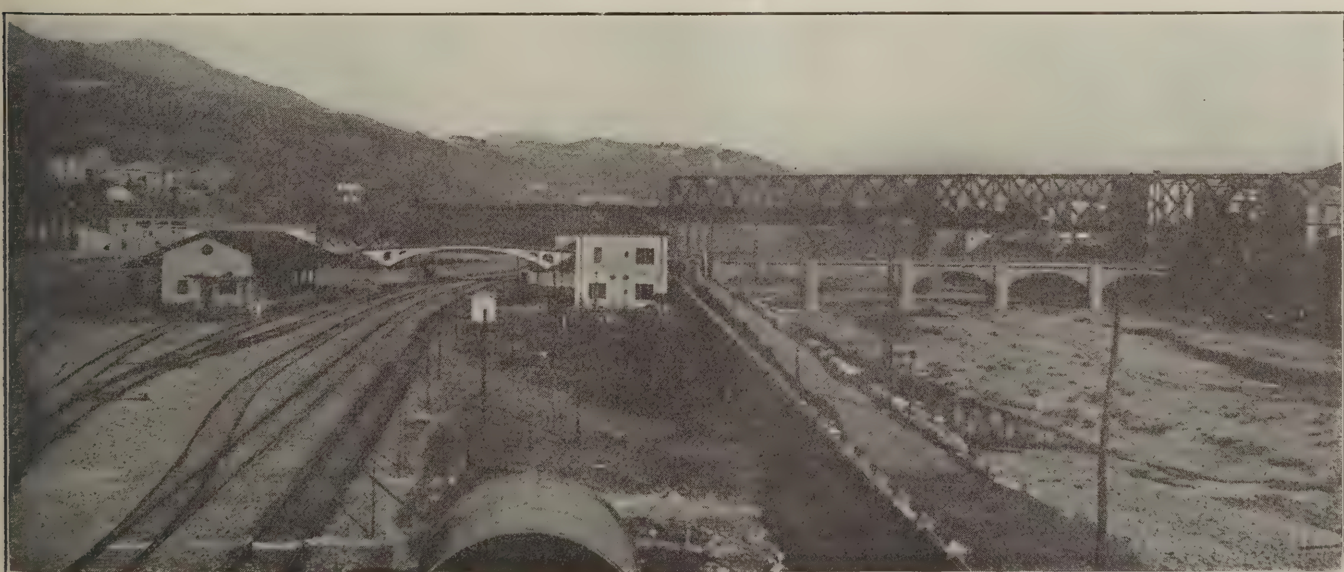
It will be seen from this that for a multitude of uses there is no satisfactory substitute for the flux-covered electrode in arc welding. The flux coating not only aids in many special ways, but actually lowers the cost of the weld by its capabilities of greater speed of deposition and surer production of consistently desirable results. Of course a skilled operator with a bare wire electrode may hold a close arc so as to cut the oxidation down as much as possible, and produce passable results, but for general use in the hands of the average operator, the fluxed electrode is best, not only because it is capable of greatly improving the weld, but because it is easier to run, and allows the operator's attention to be directed at the work instead of on the electrode. With the use of bare wire, much time is inevitably wasted in chipping, sand-blasting and brushing to remove the excess oxide, and so laborious and inefficient is the process that most operators would no more use unfluxed wire than they would unfluxed solder. There are other ways of adding flux to a weld than by means of a coating on the electrode, but these methods are mostly ineffective. Granting that flux is beneficial at all, then surely the most logical way of introducing it into the weld is at a calculated rate through a coating on the electrode, not by throwing it at the weld at intervals, or by dipping the electrode tip into a keg or box every now and then. It is maintained that puddling the molten weld with an iron rod is effective in floating some of the oxide to the surface, but this is at best a puttering process and so impractical for arc welding that it cannot compare with the quick, sure action of a good flux.

Flux coated wire is speedier and more efficient than bare wire on three counts. First, it requires less brushing, preparation and interrupting of the actual welding operation; second, the voltage across the fluxed arc is higher than across the bare rod, and the amount of work done is directly proportional to the amount of energy liberated at the arc. Hence, for the same current, the arc is proportionately faster due to the higher voltage; and there is less spatter and unnecessary oxidation with the fluxed electrode because the arc is concentrated or focused like a stream coming from a nozzle, whereas, with the unfluxed electrode, the arc shows a tendency to widen, not unlike water coming from a hose without a nozzle.

In addition to cleansing of the weld, fluxed electrodes are the only known way of adopting alloys on steel of any desired analysis, they have been the only advance made in cast iron welding and for ordinary welding they are not more costly because the increased electrode cost is far more than offset by the direct saving in labor not to mention the insurance of having the work done right the first time and always.

It had been found also that a greater proportion of the added metal is actually retained with flux coated electrodes than with bare electrodes. By comparing the weight of metal plus bare electrode before welding with the weight after welding, it has been shown that a portion of the electrode approximating 20 per cent is lost. With a flux covered electrode this loss is less than 5 per cent, indicating that more metal actually goes into the weld.

To conclude, it should scarcely be necessary to defend the use of a flux coating at all. Every metal founder knows that without the proper fluxes he would be helpless, and could not produce a perfect casting. The electric arc welding process consists of casting metal on a small and highly concentrated scale, and is so benefited by the use of fluxes to an even greater extent. On some electrodes, the flux coating is thick and heavy, on others thin; still others are half-coated, so that the arc will be encouraged ahead when the electrode is used with the bare side advancing. The added advantage of this last type lies in the protection given to the already-welded metal by the curtain of flux which drops down behind the arc and protects it from oxidation. A very heavy flux coating has not been found necessary for ordinary welding purposes, although for cutting, where an excess of oxidation is desirable, the coating may be in excess to assist the reaction. The ordinary medium-fluxed wire, however, is most effective in producing welds of consistent excellence.

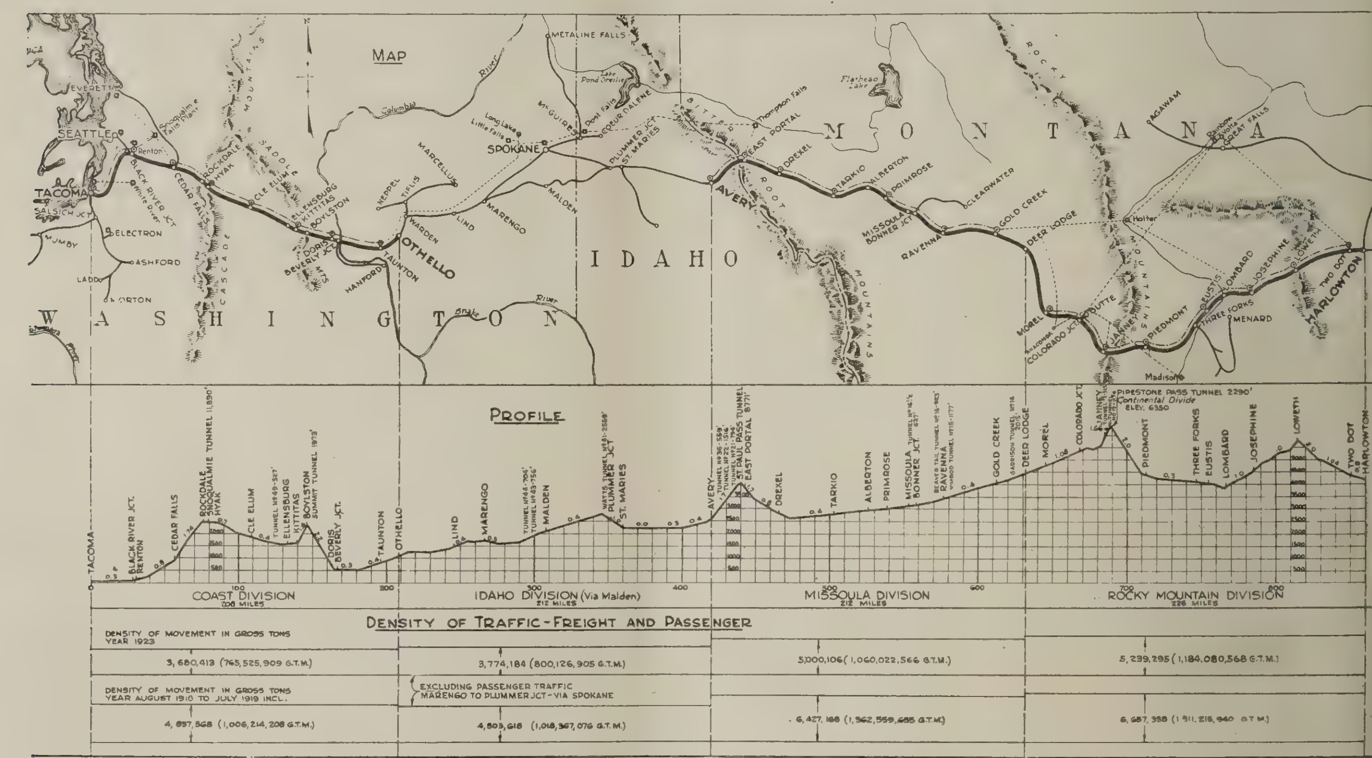


Along the Italian State Railways Near Genoa

Electrification a Great Asset to St. Paul

Report Issued by Road Shows a Saving of $12,400,007 in Nine Years' Operation

AFTER nearly nine years of operation on 438 miles of its 648 miles of electrified lines and nearly five years of service on the remaining 210 miles the Chicago, Milwaukee & St. Paul has made a detailed study of the comparative cost of operation electrically with that of previous operation with steam power which shows a marked saving from electrification. The report, signed by H. E. Byram, president, was prepared under the direction of W. W. K. Sparrow, vice-president, by Chester Oliphant, assistant comptroller, in consultation with R. Beeuwkes, electrical engineer. It indicates that on a net additional investment for electrification of $15,625,739, as explained in detail later, the saving to date over and above interest and carrying charges has been $12,400,007.



Map, Profile and Traffic Density Chart of Electrified Territories

The St. Paul started the electrification of its line in the Rocky Mountains in 1914. The first section, passing over the Big Belt and the Rocky Mountains between Harlowton, Mont., and Deer Lodge, including 226 miles of first main and 66 miles of other tracks, was placed in service in April, 1916. The Missoula division, passing over the Bitter Root range between Deer Lodge, Mont., and Avery, Idaho, and including 212 miles of first main and 62 miles of other tracks, was placed in electric operation in November, 1916.

This project, comprising a total of 438 miles of main line from Harlowton to Avery, covered what was previously four steam engine districts with intermediate terminals at Three Forks, Deer Lodge and Alberton. The Belt mountains are crossed at Summit, 45 miles west of Harlowton, at an elevation of 5,795 ft., with a one per cent grade 14 miles long on the eastern slope and a similar grade 44 miles long on the western slope. The length of this latter grade presented one of the most serious problems encountered in this installation. The Rocky Mountains are crossed at Donald, 124 miles west of Summit and 18 miles east of Butte, at an elevation of 6,350 ft. The eastern slope includes 20.8 miles of two per cent grade and the western slope 10 miles of 1.66 per cent grade. The third district between Deer Lodge and Alberton descends continuously westward on a maximum grade of 0.4 per cent. The crossing of the Bitter Root mountains is made at Roland, Idaho, at an elevation of 4,200 ft. The summit is reached by 12 miles of 1.7 per cent grade on the eastern slope and 24 miles of 1.7 per cent grade on the western slope. Over 6,250 ft. of rise and fall is overcome between Harlowton and Avery.

As would be expected in such mountainous country, the curvature is heavy, the maximum degree of curve being 10 deg. There are 36 tunnels between Harlowton and Avery, 16 of which are on the western slope of the Bitter Root mountains. The longest is the St. Paul Pass tunnel at the summit of the Bitter Root mountains, 8,751 ft. in length.

The traffic each way daily consists of two heavy transcontinental passenger trains with occasional special passenger and milk trains, and an average of four tonnage freight trains with a local freight every second day. The

freight traffic amounts to about 15,000 gross tons daily. Under ordinary conditions the prevailing tonnage is eastbound and consists largely of grain, lumber and other dead freight. Normally one time freight is able to handle all eastbound expedite business. Westbound, nearly all of the traffic consists of merchandise and other time freight.

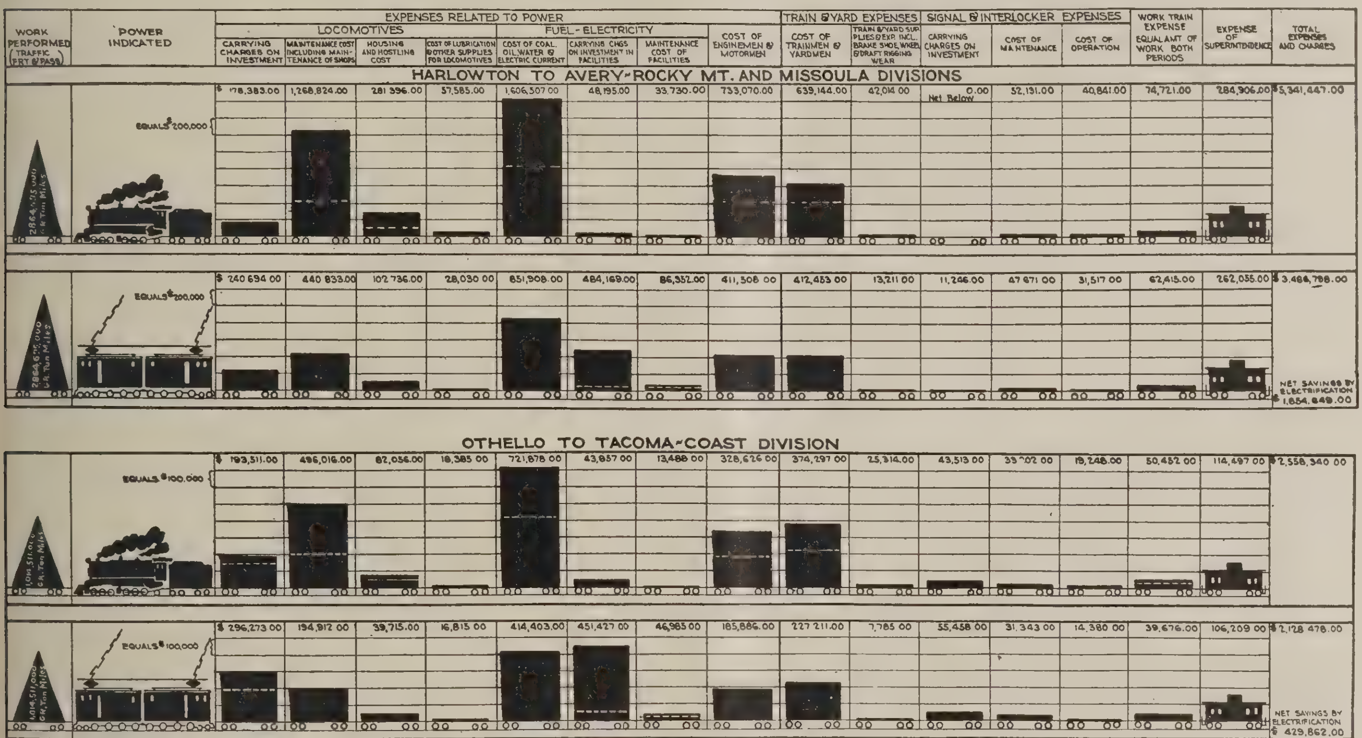
With steam locomotives a 2,000-ton train was hauled up one per cent grades with one Mallet road engine, helpers being added on the heavier grades. Seven engines were held in this service on the Rocky Mountain division, as compared with an average of 23 road engines.

The St. Paul secured the coal used between Harlowton and Avery from company mines located on its line at Roundup, Mont. In 1923 the coal for the Rocky Mountain division cost an average of $3 per ton at the point of use. During 1915 oil was used as locomotive fuel on

avoid sparking. Current is purchased at taps in the high tension lines along the right-of-way and transmitted to sub-stations, where it is stepped down from three-phase alternating current at 100,000 volts to a working voltage of 2,300 and thence converted through motor generators to direct current at 3,000 volts for distribution on the trolley. The motors of the locomotives are so constructed as to act as generators when descending grades, thus returning current to the line and controlling the speed of trains without mechanical braking.

The complete locomotive equipment for the electrified territories consists of 13 passenger, 42 freight and 4 yard locomotives. The tractive effort of these locomotives varies with the time required to pull up the grade. The equivalent number of steam locomotives necessary would be 133 freight, 23 passenger and 10 switching locomotives.

Since the electrification was placed in service marked



Comparative Cost of Electrical and Steam Operation Harlowton to Avery and Othello to Tacoma. Charts Showing Graphically the Differences in Cost and Differences in the Distribution of Costs at Volume of Traffic as of the Year August, 1918, to July, 1919, Inclusive, Including Only Operating Expenses Directly Affected by Change in Power and Carrying Charges on the Investments in the Property Directly Involved.—Comparisons should not be drawn between the Coast and Rocky Mountain & Missoula Divisions from these charts as the vertical scales are different.

the Missoula division, the oil being hauled from Puget Sound points. The oil equivalent to a ton of coal cost about $3.65 laid down at the point of use in 1923.

The electrification of the Coast division, from Othello, Wash., to Tacoma was placed in operation in March, 1920. This territory includes 208 miles of first main and 72 miles of side and yard tracks, and passes over the Saddle mountains and the Cascade mountains. The summit of the Saddle range is at Boylston, altitude 2,390 ft. while at the Snoqualmie tunnel, the summit of the Cascade range, the altitude is 2,562 ft. The maximum grade of 2.2 per cent extends for 12 miles from Doris to Boylston. The maximum grade on the west slope is 1.74 per cent on 19.2 miles between Rockdale and Cedar Falls.

The direct-current-overhead-trolley type of electrification is used. Twin trolley construction is employed to

fluctuations in the volume of traffic have been caused by the war time peak and by the slump in 1921. During 1915, the last year of steam transportation on the Harlowton-Avery section, this territory handled 2,178,631,000 gross ton-miles of passenger and freight traffic. The electrification was completed in November, 1916. The years 1917-1920 saw the peak traffic, the maximum occurring in 1919, when 2,894,063,000 gross ton-miles were handled. After the slump in 1921, when only 1,812,714,000 ton-miles were carried, the curve again began to rise and in 1923 the load amounted to 2,247,102,000 ton-miles, which is approximately equal to that of 1915. For the purpose of a study of steam and electrical operation the years 1915 and 1923 are compared.

On the Coast division the electrification was placed in full service in May, 1920. The year ending July 31, 1919,

was therefore chosen as the steam period for comparison with the year 1923 as the electrical period. However, in this case the steam period included a traffic of 1,014,511,000 ton-miles, considerably larger than the electrical adjusted to the costs prevailing in 1923. The sections were electrified at different times and have different physical and traffic characteristics, as well as different investment costs. For these reasons the report deals with the

TABLE I—VARIATIONS IN TRAFFIC AND SAVINGS RESULTING FROM ELECTRICAL OPERATION, FIGURED ON PRICE LEVELS OF 1923

Years	Harlowton to Avery—Electrical operation began April and Nov., 1916: Volume of traffic—gross ton-miles, freight and passenger	Harlowton to Avery: Net savings by electrification	Othello to Tacoma—Electrical operation began March, 1920: Volume of traffic—gross ton-miles, frt. and pass.	Othello to Tacoma: Net savings by electrification	All electrified sections: Volume of traffic—gross ton-miles, frt. and pass.	All electrified sections: Net savings by electrification
1916	†1,639,054,000	†$1,098,166	....	....	1,639,054,000	$1,098,166
1917	2,677,097,000	1,641,369	....	....	2,677,097,000	1,641,369
1918	2,759,178,000	1,734,687	....	....	2,759,178,000	1,734,687
1919	2,894,063,000	1,888,037	....	....	2,894,063,000	1,888,037
1920	2,710,745,000	1,679,623	*691,674,000	*$249,003	3,402,419,000	1,928,626
1921	1,812,714,000	658,651	664,238,000	12,363	2,476,952,000	671,014
1922	2,109,868,000	996,485	734,121,000	103,301	2,843,989,000	1,099,786
1923	2,247,102,000	1,152,508	746,405,000	119,285	2,993,507,000	1,271,793
1924	2,129,426,000	1,018,721	691,476,000	47,808	2,820,902,000	1,066,529
Total	....	$11,868,247	....	$531,760	....	$12,400,007

† Tonnage and savings for 6½ months.
* Tonnage and savings for 9 months.

operating year with only 746,405,000—a situation favoring steam operation to some extent in the comparison.

The cost of steam operation for the year 1923, if this form of operation had been employed on these electrified sections, is based upon the actual cost of steam operation for the last 12 months that such operation was in effect, cost of steam and electrical operations on each section separately.

Under either method of operation some costs, within reasonable limits, remain constant while others vary with the volume of traffic. Because of the total tonnage moved in each year being different, the unit cost, or cost per

TABLE II—OPERATING EXPENSES DIRECTLY AFFECTED BY CHANGE IN POWER—HARLOWTON TO AVERY

I. C. C. accts. (1)	Classification of expenses—Description (2)	Steam operation—Costs of the year 1915 adjusted to the price levels of 1923: *Variable: Freight (3)	*Variable: Passenger (4)	*Constant frt. and pass. (5)	Electrical operation—Actual costs of the year 1923: *Variable: Freight (6)	*Variable: Passenger (7)	*Constant frt. and pass. (8)
	Maintenance of way and structures:						
201	Superintendence	....	....	$94,472	....	....	$95,208
231	Water stations	....	....	23,800	....	....	....
233	Fuel stations	....	....	9,930	....	....	....
235	Shops and enginehouses	....	....	42,383	....	....	33,927
249	Signals and interlockers	....	....	52,131	....	....	47,671
255	Power substation buildings	....	....	....	....	....	1,530
257	Power transmission systems	....	....	....	....	....	2,913
259	Power distribution systems	....	....	....	....	....	40,763
261	Power line poles and fixtures	....	....	....	....	....	18,379
271	Small tools and supplies (for M. of Elec. Prop. only)	....	....	....	....	....	847
	Total maintenance of way and structures	....	....	$222,716	....	....	$241,238
	Maintenance of equipment:						
301	Superintendence	....	....	$120,194	....	....	$105,440
306	Power substation apparatus	....	....	....	....	....	19,163
308–11	Locomotive repairs—Train	$687,824	$218,725	....	$190,390	$135,349	....
308–11	Locomotive repairs—Switch	37,105	....	....	12,510	77	....
314–17	Brake shoe and rigging, wheel and draft rigging wear	21,352	11,622	....	....	....	....
326	Trolley maintenance cars—Only	....	....	....	....	....	2,757
	Total maintenance of equipment	$746,281	$230,347	$120,194	$202,900	$135,426	$127,360
	Transportation:						
371	Superintendence	....	....	$70,240	....	....	$61,407
377	Yardmasters and yard clerks	....	....	17,055	....	....	17,055
378	Yard conductors and brakemen	$61,533	....	....	$27,174	$166	....
379	Yard switch and signal tenders	....	....	1,189	....	....	548
380–81	Yard enginemen—Yard motormen	39,644	....	....	17,990	110	....
382–84	Fuel for yard locomotives—Yard switch. power purchased	43,315	....	....	....	....	9,489
383	Yard switching power produced	....	....	....	....	....	1,053
385	Water for yard locomotives	1,257	....	....	....	....	....
386	Lubricants for yard locomotives	777	....	....	394	1	....
387	Other supplies for yard locomotives	808	....	....	302	1	....
388	Enginehouse expense—Yard	12,431	....	....	4,131	25	....
389	Yard supplies and expenses	....	....	712	....	....	328
392–93	Train enginemen—Train motormen	400,421	121,341	....	231,352	77,778	....
394–96	Fuel for train locomotives—Train power purchased	886,009	270,693	....	....	....	754,231
395	Train power produced	....	....	....	....	....	87,135
397	Water for train locomotives	24,939	7,556	....	....	....	....
398	Lubricants for train locomotives	14,534	3,360	....	9,979	4,811	....
399	Other supplies for train locomotives	19,018	5,381	....	4,831	2,470	....
400	Enginehouse expense—Train	142,283	66,330	....	42,341	40,531	....
401	Trainmen	317,041	94,649	....	197,067	94,649	....
402	Train supplies and expenses (Train—Light and heat)	....	....	....	....	12,883	....
404	Signal and interlocker operation	....	....	40,841	....	....	31,517
	Total transportation	$1,964,010	$569,310	$130,037	$535,561	$233,425	$962,763
	Work train expense—All other than included above in M. of W. & S. adjusted to 1923 work train-miles	....	....	$74,721	....	....	$62,415
	Totals for operating expenses directly affected (Gr. Tot. Stm. $4,057,616; Gr. Tot. Elec. $2,501,088)	$2,710,291	$799,657	$547,668	$738,461	$368,851	$1,393,776
	Gross ton-miles in thousands—the work performed (Gr. Tot. Stm. 2,178,631; Gr. Tot. Elec. 2,247,102)	1,758,726	†419,905	....	1,827,197	419,905	....
	Cost per 1,000 gross ton miles	$1.54105	$1.90438	....	$.40415	$.87842	....

*"Variable"—Expenses considered to vary practically directly with volume of traffic: "Constant"—Expenses considered to remain practically constant for all volumes of traffic within a reasonable range.

†The actual for the period, 354,054,000, adjusted to the tonnage of electrical operation as the difference rests solely in the number of cars per train: Expenses adjusted to conform.

gross ton-mile for the tonnage handled in the selected years of steam operation is not comparable with the cost per gross ton-mile for the tonnage handled in the year of electrical operation. In order, therefore, to make an accurate comparison and determine the differences in cost between the two methods of operation, the costs as developed for the traffic of any one year had to be adjusted to conform to the volume of traffic of the other years. This adjustment was made by separating the costs between those items which, within practical limits for the range of tonnage under consideration, vary directly with there was little variation in the volume of tonnage as between the selected years of steam and electrical operation, are within practical limits, a true assumption, and that any possible variation would be slight and of no consequence. In the case of the Coast division where the tonnage in the year of electrical operation was very low in comparison with that of the steam period, any variation from the assumption made would have the effect of making the unit costs of electrical operation for the higher tonnages as shown in this report greater than they should be. Due to the difference in the cost levels obtaining in the

TABLE III—OPERATING EXPENSES DIRECTLY AFFECTED BY CHANGE IN POWER—OTHELLO TO TACOMA

I. C. C. accts.	Classification of expenses—Description	Steam operation—Costs of the year, August, 1918 to July, 1919, inclusive, adjusted to the price levels of 1923			Electrical operation—Actual costs of the year 1923		
		*Variable		*Constant	*Variable		*Constant
(1)	(2)	Freight (3)	Passenger (4)	frt. and pass. (5)	Freight (6)	Passenger (7)	frt. and pass. (8)
	Maintenance of way and structures:						
201	Superintendence			$48,295			$49,777
231	Water stations			8,273			
233	Fuel stations			5,215			
235	Shops and enginehouses			16,234			12,513
249	Signals and Interlockers			33,202			31,343
255	Power substation buildings						2,047
257	Power transmission systems						5,179
259	Power distribution systems						19,723
261	Power line poles and fixtures						11,066
271	Small tools and supplies (for M. of Elec. Prop. only)						365
	Total maintenance of way and structures			$111,219			$132,013
	Maintenance of equipment:						
301	Superintendence			$31,105			$22.306
306	Power substation apparatus						7,891
308–11	Locomotive repairs—Train	$326,467	$129,174		$78,549	$60,703	
308–11	Locomotive repairs—Switch	24,141			2,658		
314–17	Brake shoe and rigging, wheel and draft rigging wear	18,000	7,000				
326	Trolley maintenance cars—Only						714
	Total maintenance of equipment	$368,608	$136,174	$31,105	$81,207	$60,703	$30,911
	Transportation:						
371	Superintendence			$35,097			$34,126
377	Yardmasters and yard clerks			6,708			3,268
378	Yard conductors and brakemen	$40,560			$10,038		
379	Yard switch and signal tenders			2.047			578
380–81	Yard enginemen—Yard motormen	25,629			6,396		
382–84	Fuel for yard locomotives—Yard switch. power purchased	24,763					2,714
383	Yard switching power produced						447
385	Water for yard locomotives	602					
386	Lubricants for yard locomotives	506			.105		
387	Other supplies for yard locomotives	526			44		
388	Enginehouse expense—Yard	6,845			1,186		
389	Yard supplies and expenses			314			62
392–93	Train enginemen—Train motormen	233,323	$69,674		92,224	$38,095	
394–96	Fuel for train locomotives—Train power purchased	493,807	186,446				†319,634
395	Train power produced						53,301
397	Water for train locomotives	11,710	4,548				
398	Lubricants for train locomotives	5,606	1,758		4,804	2,171	
399	Other supplies for train locomotives	7,211	2,778		3,485	1,999	
400	Enginehouse expense—Train	45,959	29,252		14,554	16,127	
401	Trainmen	264,338	60,644		107,183	47,698	
402	Train supplies and expenses (Train—Light and heat)					7,723	
404	Signal and interlocker operation			19,248			1,380
	Total transportation	$1,161,385	$355,100	$63,414	$240,019	$113,813	$428,510
	Work train expense—All other than included above in M. of W. & S. adjusted to 1923 work train-miles			$50,452			$39,676
	Totals for operating expenses directly affected (Gr. Tot. Stm. $2,277,-457; Gr. Tot. Elec. $1,126,852)	$1,529,993	$491,274	$256,190	$321,226	$174,516	$631,110
	Gross ton miles in thousands—the work performed (Gt. Tot. Stm. 1,014,511; Gr. Tot. Elec. 746,405)	805,830	‡208,681		537,724	208,681	
	Cost per 1,000 gross ton miles	$1.89865	$2.35419		$.59738	$.83628	

*"Variable"—Expenses considered to vary practically directly with volume of traffic: "Constant"—Expenses considered to remain practically constant for all volumes of traffic within a reasonable range.

†Constant up to a total of 906,097,000 gross ton miles for freight and passenger services; thence increased in freight service as estimated necessary for greater volumes of traffic: (The amount to be added at 1,014,511,000 G. T. M. is $38,307.0C.)

‡The actual for the period, 186,232, adjusted to the tonnage of electrical operation as the difference rests solely in the number of cars per train due to difference in train routing: Expenses adjusted to conform.

the volume of traffic and those which remain constant.

When this has been done it is a simple matter to state the cost of steam operation for the tonnage of the year of electrical operation, and similarly the cost of electrical operation for the tonnage of the years of steam operation. The only assumption made in this adjustment is that the costs as separated between constants and variables have true varying and constant characteristics which, in the case of the Rocky Mountain and Missoula divisions, where different years in which the property not common to both uses was acquired, there is a considerable difference in the investment cost of such property. As interest and depreciation charges on all property used solely for either operation are in this report charged against the form of operation to which they apply, it is just as necessary to a true comparison of cost to restate such investment costs for a period having the same cost levels as it was to restate the cost of labor and material used in operation.

This has been done, using for the electrical property the actual cost figures and for the steam property no longer in use on the electrified sections and which consequently has either been released for use on other divisions of the railroad, or retired from service, what such property would have cost new at the time of the purchase and installation of the electrical property.

No savings have been credited to electrical operation which are not susceptible of direct ascertainment, as for example, the possible increased revenue due to the release of equipment used in the transportation of coal when these divisions were under steam operation, better utilization of freight equipment due to faster movement, less wear and tear on road and equipment, less station expenses affected by the number of trains required to handle a given tonnage, or increase in passenger revenue due to the attractiveness and greater comfort of travel under electrified operation.

Table IV—Investment in and Carrying Charges on the Property Peculiar to Each Mode of Operation—Harlowton to Avery

(438 Roadway miles)

Items	Investment *	Carrying charges: Interest 5%	Carrying charges: Depreciation S. F. Basis 6%	Total
Steam operation—Fixed property:				
Fuel and water stations, cinder pitts, etc.	$630,000	$31,500	$16,695	......
D. C. signal system	†......	......	......	......
Totals, fixed property	$630,000	$31,500	$16,695	$48,195
Locomotives:				
Freight (incl. all pusher work service locomotives)	$2,470,628	$123,531	$28,165	......
Passenger	356,039	17,802	4,059	......
Switch	78,598	3,930	896	......
Totals, locomotives	$2,905,265	$145,263	$33,120	$178,383
Totals, steam property	$3,535,265	$176,763	$49,815	$226,578
Electrical operation—Fixed Property—				
Roadway buildings	$89,545	$4,477	$2,382	......
Power substation buildings	535,157	26,758	3,361	......
Power substation apparatus	1,859,353	92,968	21,383	......
Power transmission system	715,181	35,759	5,435	......
Power distribution system	2,890,615	144,531	23,269	......
Power line poles and fixtures	1,091,721	54,586	50,110	......
A. C. signal system	†197,446	9,872	1,374	......
Engr.—Int. during construction and miscellaneous	325,671	16,284	3,354	......
Maintenance equipment	37,000	1,850	422	......
Sub-total	$7,741,689	$387,085	$111,090	$498,175
Rental of transmission lines—Credit	......	Cr.$2,760	......	Cr.$2,760
Totals, fixed property	$7,741,689	$384,325	$111,090	$495,415
Locomotives:				
Freight (incl. all pusher and and work service locomotives)	$2,881,112	$144,056	$32,845	......
Passenger	927,408	46,370	10,573	......
Switch	111,564	5,578	1,272	......
Totals, locomotives	$3,920,084	$196,004	$44,690	$240,694
Totals, electrical property	$11,661,773	$580,329	$155,780	$736,109
Increase in carrying charges—Account electrification	......	......	......	$509,531

*Electrical operating property at actual cost 1914-15-16: Steam operating property priced as of the costs obtaining during the same period (1915).
†Net increase in investment chargeable to electrification included under electrical operation.

Savings Resulting from Electrical Operation—Cost Level of 1923

Table I shows for the years since the beginning of electrical operation the net savings from electrical operation, using for steam operation the actual costs for the last 12 months of such operation, adjusted to the costs obtaining in 1923; and for electrical operation, the actual costs as determined for the year 1923. The net savings shown are obtained by deducting from the savings in operating expenses the carrying charges of interest and depreciation on the additional investment required by electrification. This additional investment amounts to $15,625,739, as shown in detail later.

From this table it will be seen that for the year 1923, with its comparatively low tonnage, the net savings from electrical operation of the two sections amounted to $1,271,793. For the minimum tonnage so far experienced, which was in the year 1921, the savings amounted to $671,014. The maximum tonnage handled so far was in the year 1919. If the section from Othello to Tacoma had been under electrical operation during that year the savings for the two sections would have amounted to $2,355,199. The total accrued net saving by electrification aggregates $12,400,007, or slightly more than three-fourths of the cost of the electrification.

Operating Expenses Directly Affected by Change in Power

Statements of the costs of electrical and steam operation as collected from the detail work sheets, together with certain traffic, fuel and locomotive statistics used or given consideration with the costs, are shown in Tables II and III. The selection accounts used was made after a careful study of the expenditures under each of the primary accounts of the operating classification. Some of the accounts excluded as not being affected by the change in power are without doubt affected to some extent, but the effect is so slight as to be negligible in comparison with the effects produced by other causes. For example, "Maintenance of Track" is an expense unquestionably affected to some extent by the class or kind of power, but the effects from other causes such as weather, availability of money, cycles of renewals of parts, maintenance programs, labor conditions, etc., are so much greater and so impossible of exact ascertainment for elimination, that the expense can only be classified as not being affected by change in power. Work train expenses have been separated and included as expenses directly affected by changes in power for several reasons, one of which is that certain stand-by losses under steam operation are eliminated by using electric motors in work train service. The costs of the two periods have been adjusted to the same amount of work train service.

As the price levels of labor and material were not the same for the periods of electrical and steam operation, it was necessary to bring the costs to the same level so that a true comparison could be made. To this end the costs of the steam periods have been restated as of the electrical period and hence all the operating expense costs in this report are for the price levels of 1923.

With respect to the savings through the use of regenerative electric braking, it was found that no existing data were available which would enable the brake shoe wear to be determined with any accuracy for the condition of continuous and long application which, under steam operation, occurs on mountain grades. Therefore a wear figure, believed at least to be conservative, of one pound of wear per 100,000,000 foot-pounds of energy dissipated was used. There is also a saving in draft rigging and braking apparatus and in wheel wear, all of which are for evident reasons where cars move over many divisions indeterminable. The amount of savings on account of these items was assumed to be the same as that resulting

from the reduction in brake shoes wear. This is believed to be conservative.

Costs of electric power are based upon a minimum total payment corresponding to the respective kilowatts for which the railway company in 1923 had exercised option for the different sections. Where these respective amounts of kilowatts are not sufficient to handle the increased traffic, power cost has been increased on the basis of the additional kilowatts required.

Separation of Affected Operating Expenses Between Constant and Varying Items

The total tonnage moved in the selected years, or any year that could have been selected, for steam operation was not the same as the tonnage moved in the year of electrical operation. Therefore, in order that the costs of electrical and steam operation might be stated for different volumes of traffic, within a reasonable range of the tonnage which has been handled over these divisions, without which a correct comparison between the cost of steam and electrical operations could not be made, the costs affected by a change from steam to electrical operation were separated between those which within reasonable limits remain constant for different volumes of traffic, because they are not connected with the direct movement of traffic, and those which on account of being connected with the movement of traffic vary directly with the volume of traffic. The expenses which within practical limits vary directly with the volume of traffic have been separated further between passenger and freight service, as such expenses can be directly assigned. With these separations in the expenses, the costs of operation for the volumes of traffic dealt with in this report may be obtained readily. It is only necessary to multiply the gross ton-miles of each service at any volume point by the respective unit costs developed, and to the sum of the products so derived add the total constant cost.

TABLE V—INVESTMENT IN AND CARRYING CHARGES ON THE PROPERTY PECULIAR TO EACH MODE OF OPERATION—OTHELLO TO TACOMA

(208 Roadway miles)

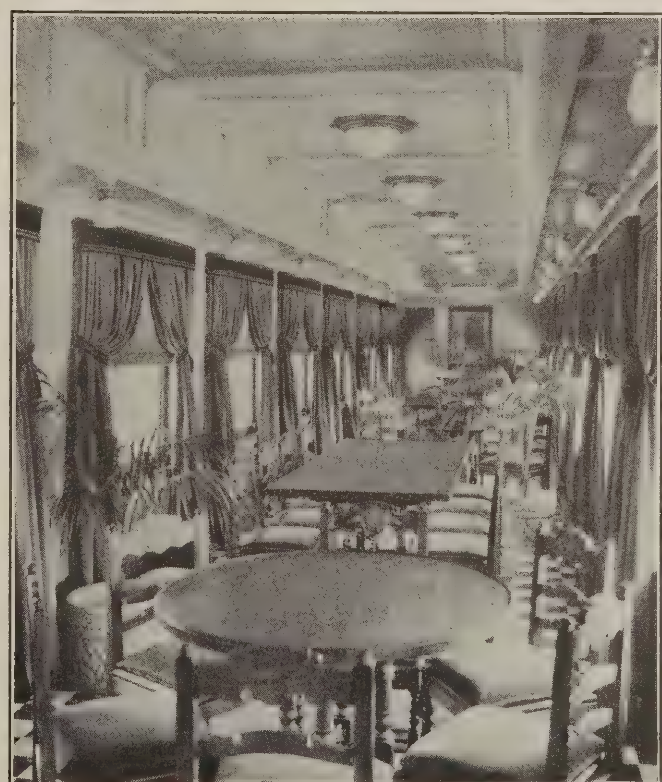
Items	Investment *	Carrying charges: Interest 5%	Carrying charges: Depreciation S. F. Basis 6%	Total
Steam operation—Fixed property:				
Fuel and water stations, cinder pitts, etc.	$507,010	$30,421	$13,436	......
D. C. signal system	612,000	36,720	6,793	......
Totals, fixed property	$1,119,010	$67,141	$20,229	$87,370
Locomotives:				
Freight (incl. all pusher and work service locomotives)	$2,135,785	$128,147	$24,348	......
Passenger	430,231	25.814	4,905	......
Switch	144,224	8,653	1,644	......
Total, locomotives	$2,710,240	$162,614	$30,897	$193,511
Totals, steam property	$3,829,250	$229,755	$51,126	$280,881
Electrical operation—Fixed property:				
Roadway buildings	$114,215	$6,853	$3,027	......
Power substation buildings	452,808	27,168	2,875	......
Power substation apparatus	1,476,964	88,618	16,985	......
Power transmission system	549,521	32,971	5,072	......
Power distribution system	2,190,401	131,424	16,822	......
Power line poles and fixtures	966,563	57,994	40,596	......
A. C. signal system	780,000	46,800	8,658	......
Engr.—Int. during construction and miscellaneous	621,519	37,291	7,645	......
Maintenance equipment	27,000	1,620	308	......
Sub-total	$7,178,991	$430,739	$101,988	$532,727
Rental of transmission lines—Credit	......	Cr.$25,842	......	Cr.$25,842
Totals, fixed property	$7,178,991	$404,897	$101,988	$506,885
Locomotives:				
Freight (incl. all pusher and work service locomotives)	$3,065,280	$183,917	$34,944	......
Passenger	1,035,690	62,141	11,807	......
Switch	48,520	2,911	553	......
Totals, locomotives	$4,149,490	$248,969	$47,304	$296,273
Totals, electrical property	$11,328,481	$653,866	$149,292	$803,158
Increase in carrying charges—Account electrification	......	......	......	$522,277

*Electrical operating property at actual cost 1917-18-19: Steam operating property priced as of the costs obtaining during the same period (1918).

Carrying Charges on the Investment

The property here considered is the power equipment and the facilities and appurtenances directly related thereto—as, for example, in steam operation, the fuel and water stations and in electrical operation, the transmission and distribution systems, sub-stations, etc. The signal systems are also included as it was necessary to change out the direct current systems for the alternating current systems on account of the electrification making the direct current signaling impractical.

Investment for the property peculiar to electrical operation was taken as of the actual cost of installation—on the Coast division, as of the prices obtaining in 1918 (1917 to 1919); on the Rocky Mountain and Missoula division, as of 1915. The carrying charges computed upon the investments and included as cost are interest and depreciation. The interest rate has been taken at the rate paid by the St. Paul during the different periods of installation—for the Coast division 6 per cent and for the Rocky Mountain and Missoula divisions 5 per cent. Depreciation has been computed upon the sinking fund basis, using an interest rate of 6 per cent.



Unusual Dining Car Appointments Used on Special Pullman Tourist Train in Cuba

Elementary Theory of Alternating Currents

A Series of Practical Articles Explaining a Difficult Subject in a Simple Manner

By K. C. Graham

Part X Induction Motor Windings

ALTHOUGH this article is entitled Induction Motor Windings it applies equally well to the stator windings of generators or of synchronous motors for the stator windings of each of them might be used interchangeably if occasion demanded. In practice, however, it is usually with the windings of the induction motor that we come into contact and, therefore, any article dealing with such windings must be concerned, primarily, with those of the induction motor.

One point that must be thoroughly understood before we can proceed to study induction motor windings is the difference between mechanical and electrical degrees. This subject has been mentioned previously in these articles, but it will do no harm to treat of it again in a more thorough manner.

Fig. 94 (a) shows a two-pole machine whose armature contains the coil x-y one side of which is under the center of the N pole and the other side of which is under the center of the S pole. Since a circle contains 360 degrees it will be seen that these two conductors are one-half circle or 180 degrees apart. Now, the manner of designating electrical degrees is such that the distance between the centers of two like poles is taken as 360 electrical degrees. Therefore the distance between two unlike poles, which are necessarily adjacent, is 180 degrees. Thus in this case the distance between x and y will be 180 electrical degrees and the distance from x around the circle to x again will be 360 degrees. In the case of a two-pole machine the electrical and mechanical degrees are the same. With a multipolar machine (more than two poles) this relation does not hold good as we shall see upon referring to Fig. 94 (b) which shows a four pole machine. The distance between the centers of the two N poles measured mechanically is 180 degrees, but as mentioned above, the distance between two like poles in electrical degrees is 360. Therefore the distance between conductors x and z will be 360 electrical degrees; the distance between x and y 180 degrees, between y and z 180 degrees, etc. The reason that we must be so particular as to our understanding of electrical and mechanical degrees is that the two conductors of a coil must be spaced 180 electrical degrees apart in order to generate the highest possible voltage in the coil and, therefore, we must have a thorough understanding of this feature in order to place conductors in their proper position. Thus, in Fig. 94 (c) is shown an armature for a six pole machine on which we wish to space, properly, the six conductors of the three armature coils. Now we know that the distance between two north poles is 360 electrical degrees and that there are three of these north poles so that the distance around the circle in electrical degrees will be 1080 degrees or three times as much as the distance around expressed in mechanical degrees. Therefor the conductors would be spaced one-third of 180 mechanical degrees apart or 60 degrees, this being equal to 180 electrical degrees.

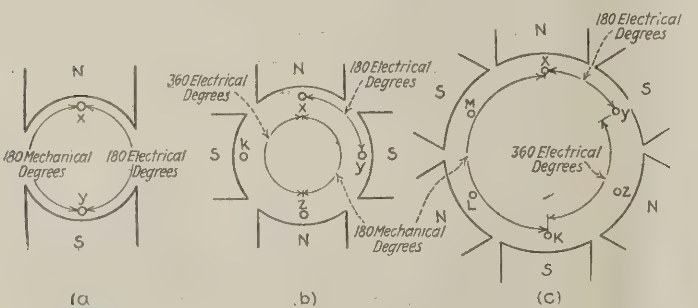


Fig. 94

It would also be advisable to review the theory of voltage generation because it is necessary that we understand this feature in order to grasp the reasons for the various devices resorted to in laying out windings for alternating current machines—viz. distribution of the winding, chording, etc.

If we denote the value of the flux emanating from one of the poles by ϕ conductor x, Fig. 94 (a) will cut across 2ϕ lines in a complete revolution. Conductor y will cut across a like number so that the number of lines cut by the coil, the two conductors of which are connected in series, will be 4ϕ lines per revolution. If the frequency of the generated voltage is 60 cycles then the armature will revolve (in the case of a two pole machine) at the rate of 60 revolutions per second so that the total number of lines cut by the coil in one second will be $4\phi f$—where f denotes frequency. If there were two of these coils connected in series the number of lines cut would be 2 times this value; if three coils, 3 times this value and so on. If we designate the number of coils in series by the symbol n, our formula becomes $4\phi fn$ for the number of lines cut per second. We learned in connection with the study of correct currents, that it was necessary for a conductor to cut 100,000,000 of these lines per second in order that one volt might be generated in it. Thus to find the voltage generated in the armature we must divide our previous formula by this value,—viz. Volts $= \dfrac{4\phi fn}{100{,}000{,}000}$.

Now let us see how our formula will be affected if we substitute a four pole machine for the two pole one we have just considered. In Fig. 94 (b) conductor x will cut 4ϕ lines per revolution and the coil which is made up of the two conductors x and y will cut 8ϕ lines per revolution so that our formula appears to be changed already. But let us look further. The number of revolutions per second will be just half that in the case of the two pole machine or, in this case, 30 per second or $\dfrac{f}{2}$.

We must still use the factor n to designate the number of coils connected in series so that our formula becomes,

$$\text{Volts} = \frac{8\Phi \frac{f}{2} n}{100,000,000}$$

or, reducing the numerator to its simplest terms $\text{Volts} = \dfrac{4\Phi f n}{100,000,000}$ as before so that we see that the formula holds good in all cases regardless of the number of poles. The value obtained by the above

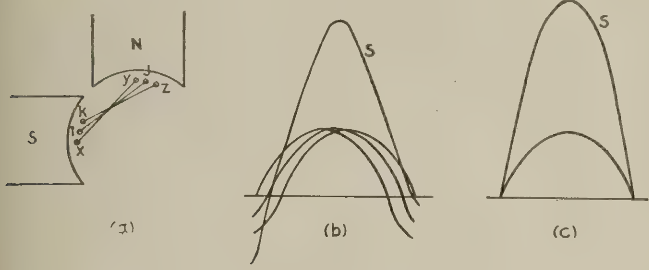


Fig. 95

formula indicates the average value of the alternating voltage, but this is not the value indicated by an alternating current measuring instrument, or in other words it is not the effective value of the alternating current. As we learned, in connection with the study of elementary generation, the effective value of an alternating voltage is 1.11 times the average value so that it will be necessary to multiply our formula by this factor in order that it may be complete. Multiplying we have,

$$\text{Volts} = 1.11 \text{ times } \frac{4\Phi f n}{100,000,000} \text{ or volts} = \frac{4.44\Phi f n}{100,000,000}.$$

It is well to spend enough time to memorize this formula because it is the basis for all alternating current calculations relating to the design of windings for motors, generators, transformers and other apparatus.

Distribution Factor			
Slots per Pole per Phase	Single Phase	Two Phase	Three Phase
1	1.000	1.000	1.000
2	.707	.924	.966
3	.663	.911	.960
4	.653	.906	.958
6	.644	.903	.956

Fig. 96

If three coils *x-y*, *i-j*, and *k-z*, Fig. 95 (a), are connected in series the voltage will not be, strictly, equal to the sum of the three voltages because they are out of phase with one another as shown in Fig. 95 (b). When they are added together the sum will be as shown by curve *S* Fig. 95 (b). Had these three coils been in the same slots they would have added directly so that their sum would have been equal to three times the value of any one of their voltages as in Fig. 95 (c). Where the coils of the same pole that are connected in series are not all in the same slots as in Fig. 95 (a) the winding is known as a *distributed* winding, and where all the coils, connected in series, are in the same slot the winding is known as a *concentrated* winding. Therefore in order to obtain a true value of the voltage generated in the winding it would be necessary to multiply our formula by a factor that would take this distribution loss into consideration. The factor so used is termed the "distribution factor" and its value may be determined from one of the numerous tables that are available and that are calculated for various numbers of slots and coils per pole. Such a table is

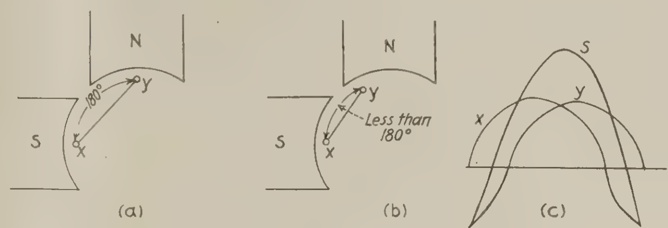


Fig. 97

shown in Fig. 96. For the concentrated winding the value is, of course, one. The other values are calculated with due consideration for the distance in degrees, that the coils are out of phase with one another. This will, in turn, be governed by the number of phases and the number of slots into which the winding is distributed.

Another device that is often resorted to is that of chording the winding. The meaning of this term will be readily grasped upon consideration of Fig. 97. Fig. 97 (a) shows the two conductors x and y spaced 180 electrical degrees apart. With this spacing the voltage generated in the coil, which they comprise, will be of the highest possible value. It is advisable, at times, however, to space the two conductors of the coil less than 180 electrical degrees apart as in Fig. 97 (b). The voltages generated in the two sides of the coil will then be out of

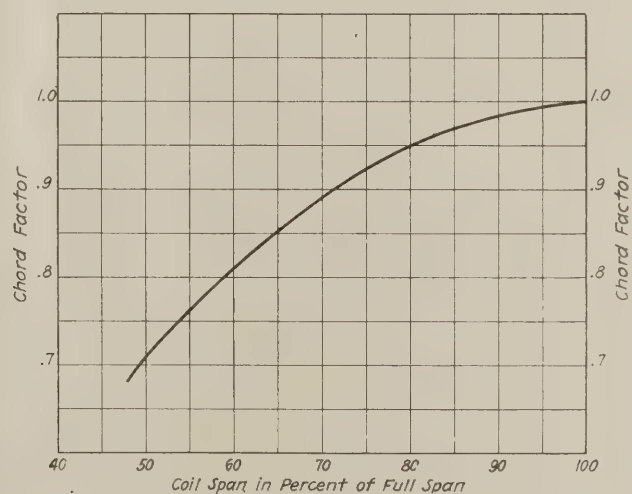


Fig. 98

phase with each other and cannot, therefore be added directly. The resultant sum of these two voltages will be somewhat less than the direct sum of the two voltages as shown in Fig. 97 (c). When the winding is chorded in this manner it will be necessary to multiply our formula by a chording factor which is similar to the distribution factor previously considered.

Fig. 98 shows a curve of such "chord factors." It will be seen that the chord factor depends solely on the percentage of 180 degrees or full coil span that the coil sides are spaced. Therefore to obtain an absolute value

for the voltage generated in a given winding it will be necessary to multiply our basic formula by the two factors of distribution and chording. It might be wondered just why chording should ever be resorted to; there are two main reasons, one is to cut down the distance that the end connections of the coils project outward from the core, and the other is to eliminate harmonics in the generated voltage wave. The manner in which the endroom is conserved is illustrated in Fig. 99.

In Fig. 99 (a) it is necessary for coil *1* to project out from the core such a distance that it shall clear coils *2*, *3* and *4* at point *K*; or in other words the distance *K-L* must be such as to accommodate the end connections of the winding. In Fig. 99 (b) where the coils are chorded the distance *K-L* need only be such that the end connection of coil *1* shall clear coils *2* and *3*. This results in a saving in the depth of the endbell that bolts to the stator frame and which carries the bearings that support the rotor. Incidentally, the length of wire necessary to wind the stator is reduced, thus reducing the resistance loss

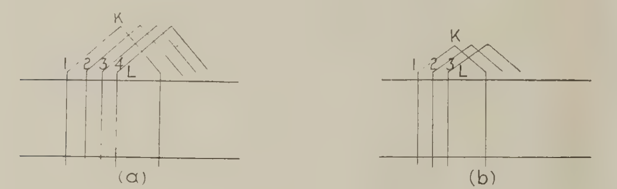


Fig. 99

and, in this way, making a more efficient machine. Although these savings may appear small it is such little economies as these that keep manufacturing companies operating in the face of present day competition.

Fig. 100 serves to illustrate just what is meant by harmonics and the manner in which they are overcome by chording the winding. With an even distribution of flux in the airgap the curve of flux distribution may be represented by Fig. 100 (a). This, however, is only an ideal condition that is rarely found in practice. There are many reasons why the flux distribution is not uniform: different degrees of saturation in the various parts of the circuit, variations in the depth of the airgap, positions of the slots and teeth relative to the poles at any given instant and the shape of the poles themselves. Let us suppose that the shape of the wave is as shown in Fig. 100 (b). This wave may be considered as being made up of the fundamental sine wave *A* and the smaller wave *C*,

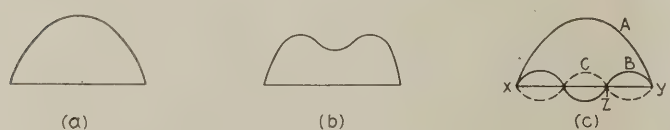


Fig. 100

of triple frequency. This wave is said to contain a third harmonic because the frequency of this smaller superimposed wave is three times that of the main wave. This shape of wave naturally generates the same shape of voltage wave, this wave in turn causing a like wave of current. Now a pulsating wave such as this reacts unfavorably on the transmission line or, with several such coils connected in series, upon the machine itself. Thus currents may be caused to circulate within the windings themselves when no current is being taken from the machine or, in the case of the transmission line, destructive surges of current may result from these pulsating waves. These harmonics may be eliminated by chording the coil so that its two sides are out of phase a degree equal to the width of the harmonic wave. In this case of the third harmonic, if the conductor *y* of the coil is brought closer to the conductor *x* a distance represented by *yz* Fig. 100 (c) the harmonic generated in *y* will be directly opposed to that in *x* so that it will be eliminated as shown by the dotted curve and only the unobjectionable fundamental sine wave of e.m.f. shall remain. The elimination of harmonics is only considered in connection with generator windings, but chording is resorted to in the case

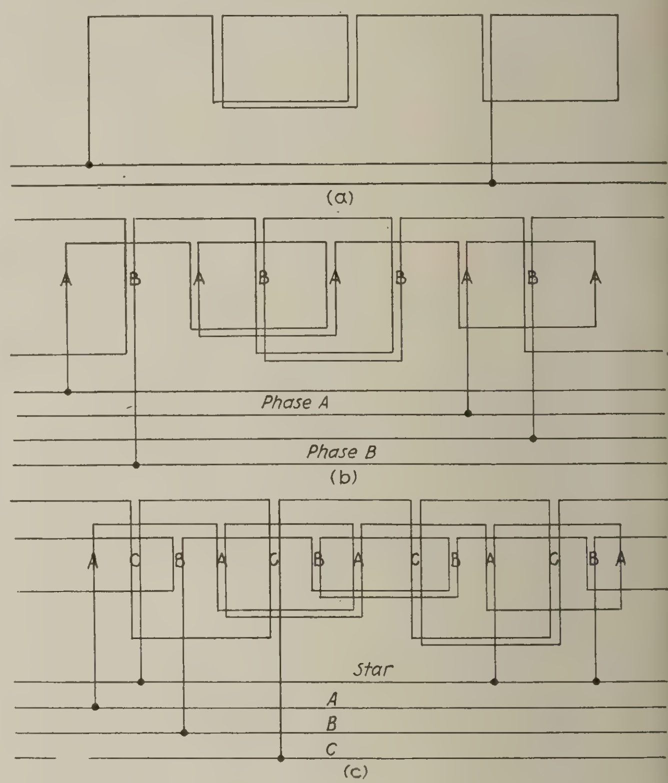


Fig. 101

of motor windings for the other reasons mentioned above.

There are two general classes of windings, chain or single layer windings and two layer windings.

Fig. 101 (a) shows a developed diagram of a single layer single-phase winding; Fig. 101 (b) a single layer two-phase winding and Fig. 101 (c) a single layer three-phase winding. As the name implies there is only one layer to the winding of any one phase, or in other words the windings of any given phase do not lap over the another. This winding is used for high voltage machines where good insulation between coils is a prime requisite. This feature could not be satisfied by the use of a two layer winding without sacrificing entirely the cooling of the end connections of the coils. With the chain method of winding the conductors of the coil are concentrated in a small bundle which is thoroughly insulated and which, when installed has plenty of room around it for the flow of the cooling air.

Fig. 102 (a) shows a developed diagram of a two layer lap connected single-phase winding, Fig. 102 (b) a two-phase of the same type and Fig. 102 (c) a three phase. Although it is not so easy to cool the end connections and its insulating qualities are not so good as the chain

winding this type of winding is more generally used than the chain winding because only one shape of coil is necessary, the coils are cheaper to make, as a rule, they are really easier to install than are the chain windings so that the saving in labor is large, a greater economy of space is possible than with the chain winding and its insulating qualities are ample for moderately low voltages up to 2200 volts.

Fig. 103 (a) shows a developed diagram of a two layer wave connected single-phase winding and Fig. 103 (b) the same type of two-phase winding. This type of

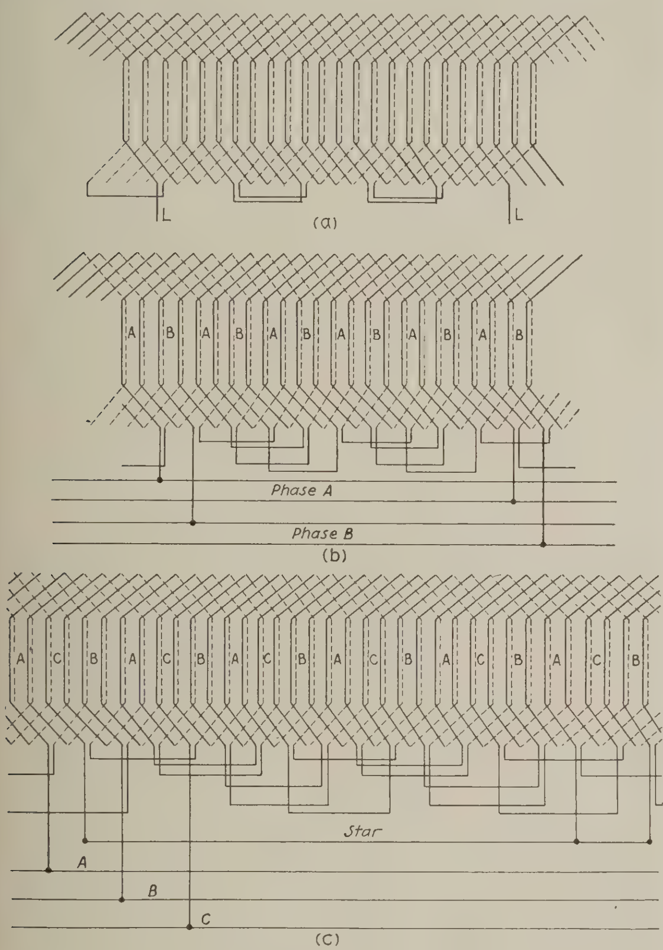


Fig. 102

winding is rarely used on stators, but is often found on wound rotors of induction motors. Its main advantage is that is provides a mechanically balanced winding that is very acceptable for a wound rotor that would operate rather unsatisfactorily with a mechanically unbalanced winding even though this unbalance were overcome by the addition of properly placed balancing weights which are not very satisfactory at best. With the winding distributed in several slots per pole per phase it may be connected progressive or retrogressive just as in a direct current machine. The winding shown in Fig. 103 (a) is progressive because it moves ahead one division in a revolution—i.e. it more than completes the circuit in one turn around the armature. It would be retrogressive if it completed less than a revolution in one turn around the armature.

Windings may again be divided into half-coil and whole-coil windings. Fig. 104 (a) shows a half coil and Fig. 104 (b) a whole coil winding. It will be seen that they take their names from the fact that there is only one coil per pair of poles in the case of the half-coil winding whereas there are two coils per pair of poles in the whole-coil type. The half-coil is little used, all modern windings being of the whole-coil type.

A winding consists of a number of coils made up of

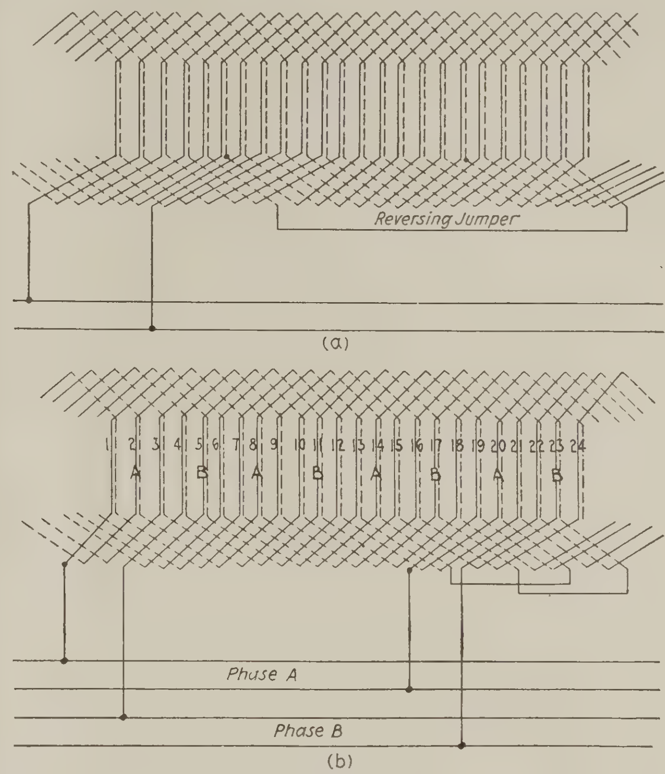


Fig. 103

several turns or loops. This will be better understood upon consideration of Fig. 105.

Fig. 105 (a) shows a coil consisting of a single turn, while Fig. 105 (b) shows a coil made up of three turns. Either of these coils could be used for a concentrated or a distributed winding; concentrated if either one alone were the only coil per pole per phase, or distributed if

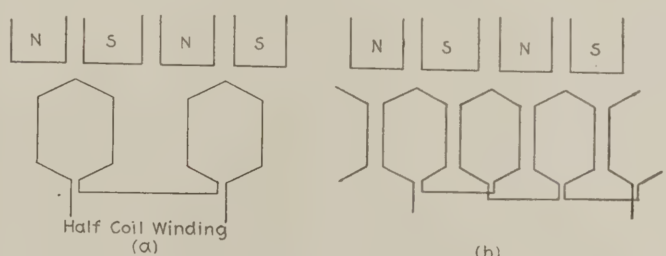


Fig. 104

two or more were connected in series per pole as in Fig. 105 (c). This method of connecting together the several coils that go to make up a phase pole of a distributed winding is termed "grouping." As an example of the procedure in laying out a winding, suppose a three-phase four-pole stator is wound with 96 coils. Since it is three-phase there shall be 32 coils per phase and, since it is four pole, there shall be 8 coils grouped in series to form a phase pole. If the machine were a 48 slot instead of a 96

slot one there would have been only four coils per group. After the winding has been "grouped" these groups are connected together in one of a number of ways that we shall learn of shortly.

Fig. 106 (a) shows an extended view of a single-phase lap winding. It will be seen upon tracing through the winding that the coils are so connected that they are alternately north and south in exactly the same manner as we connect the field coils of a direct current machine.

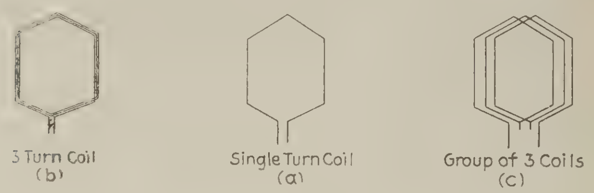


Fig. 105

It should be noted that there are two coils per group. Fig. 106 (b) shows a circle line diagram of the winding. Each of the small circular arcs represent a group. The manner in which these groups are connected together is clearly shown in the figure, the small arrows indicating the direction in which the current progresses through the group—viz. right to left or left to right as the case may be. Fig. 106 (c) shows a developed diagram of this same winding, the coils being shown as if they were stretched out in a straight line just as if they had been

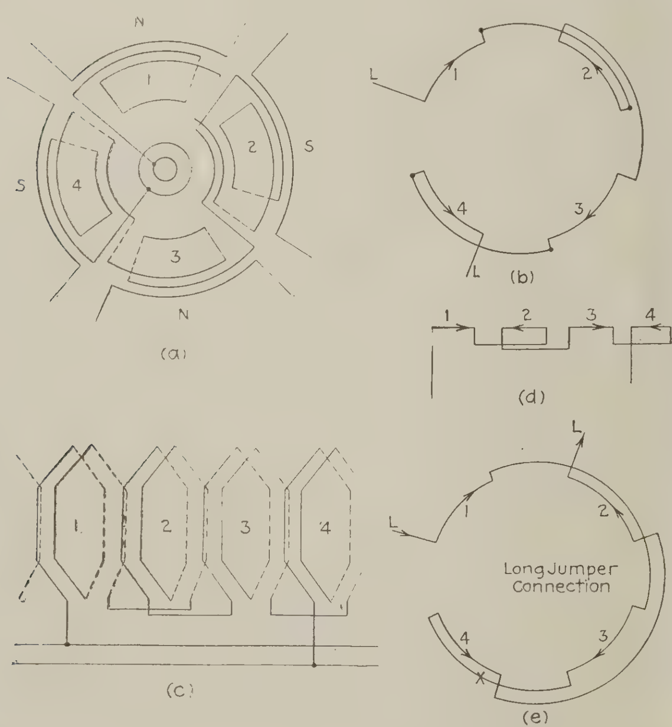


Fig. 106

placed on the outside of a cylinder and we had split the cylinder and rolled it out straight. A straight line diagram of this winding is shown in Fig. 106 (d). It bears the same relation to the developed diagram that the circle line diagram bears to the extended diagram. Each of these pictures show the manner in which the groups are connected, but the two line diagrams are the more generally used because of the fact that they are easier to construct. Of the two, the circle line diagram is the more accurate because it shows the groups as they are actually laid out while the straight line form does not—thus Fig. 106 (b) shows group 4 right next to 1 whereas Fig. 106 (d) shows 4 at one extreme and 1 at the other. Of course they are both correct, but Fig. 106 (d) requires the use of the imagination in order that we may picture the actual condition while Fig. 106 (b) does not require any effort on our part. This will be more clearly seen in some of the more complicated diagrams that we shall look into later on. Fig. 106 (e) shows a circle line diagram, of the same winding, that is essentially the same as that of Fig. 106 (b) except for the fact that group 1 is connected to 3, and group 3 is connected by the reversing jumper *x* to group *4* and thence across to group

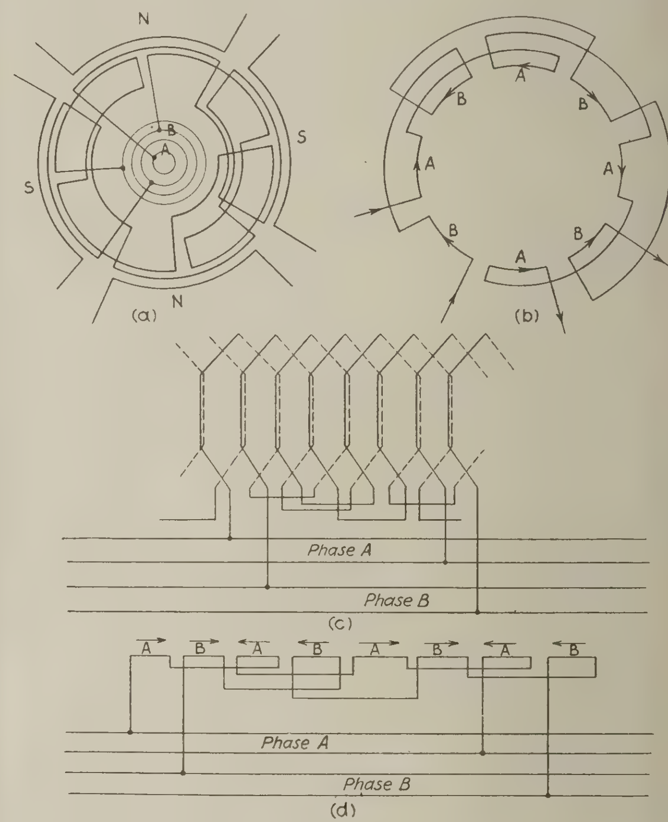


Fig. 107

2. It will be seen that where possible we have skipped a group between connecting points. Thus we skipped 2 to get to 3, but we had to connect 3 to 4 in order to maintain the series connection; we then skipped 3 in going from 4 to 2. This type of winding is called a long-jumper winding in contrast to Fig. 106 (b) which is called a short-jumper winding. It might seem, off-hand, that we are going to an unnecessary lot of trouble in connecting a machine long-jumper, but there are several reasons for using this connection. In a single circuit connection such as this the long jumper would not be of any particular advantage except that it would permit of the jumpers being laid down in a more symmetrical manner. On multi-circuit machines, such as we are about to take up, this connection is very useful in preventing internal circulating currents due to variations in the depth of the airgap resulting from slight manufacturing defects or from bearing wear.

Fig. 107 shows a single-circuit four-pole two-phase diagram laid out in the same manner as that of Fig. 106. A

similar three-phase winding is shown in Fig. 108 which is very much like Fig. 107 except for the fact that the extended and the developed diagrams are omitted. The (a) and (b) sketches show a star-connected winding while (c) and (d) show a delta connected winding.

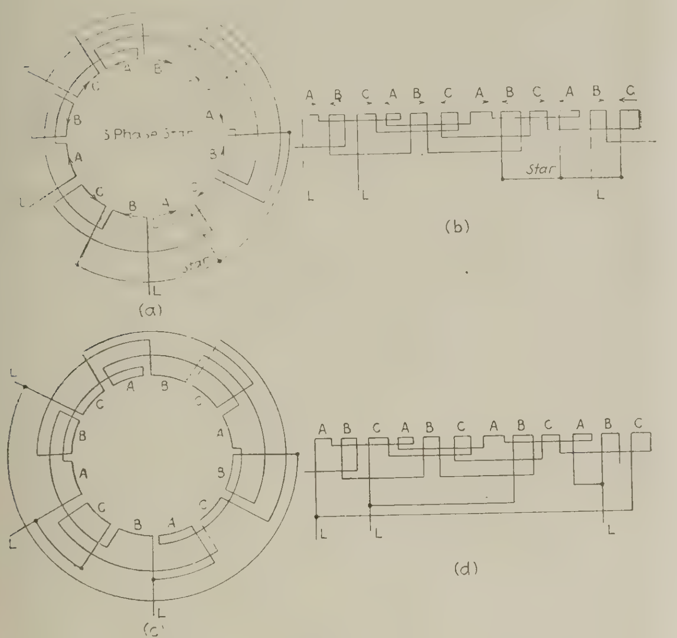


Fig. 108

The directions of the arrows in the single, two and three-phase diagrams should be noted carefully. In the single-phase winding the arrows alternate, in the two-phase winding they alternate by twos, two one way and two the other, while in the three-phase star connection they alternate if we imagine the currents in the three phases flowing into the star. The same thing applies in the case of the delta connected winding if we imagine two of the leads disconnected from each other, as noted at x Fig. 109 (c) and current caused to flow in one of them, through the winding and out the other one. The arrow check is the most useful device for checking up wrong winding connections as shown in Fig. 109.

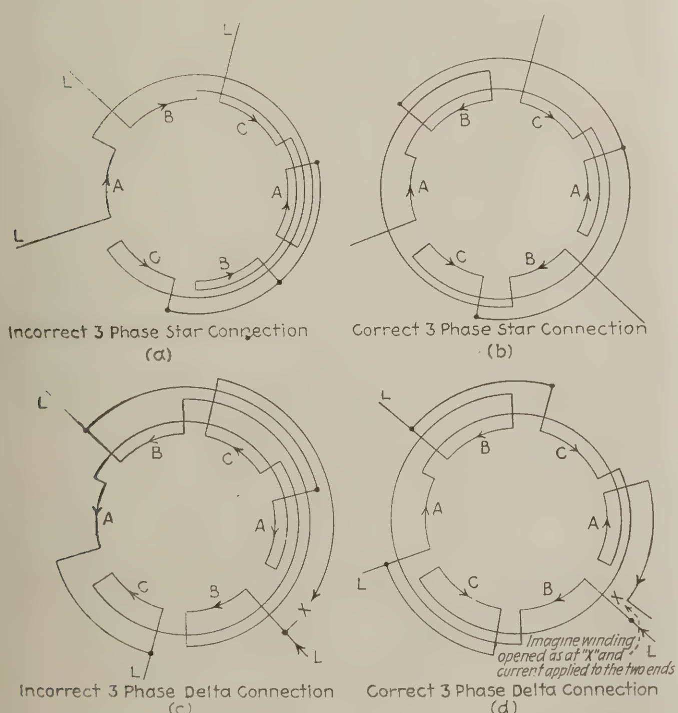


Fig. 109

Fig. 109 (a) shows an incorrect or 60 degree three-phase star connection. The arrow check shows this connection to be incorrect and the correction is shown in Fig. 109 (b). Fig. 109 (c) shows an incorrect delta winding while Fig. 109 (d) shows the correct connection. The relative directions of the arrows should be noted in the two cases. The method of making the arrow check should be particularly noted in the case of the delta winding.

Fig. 110 shows circle line diagrams for four, six and eight pole, two and three-phase windings; one and two

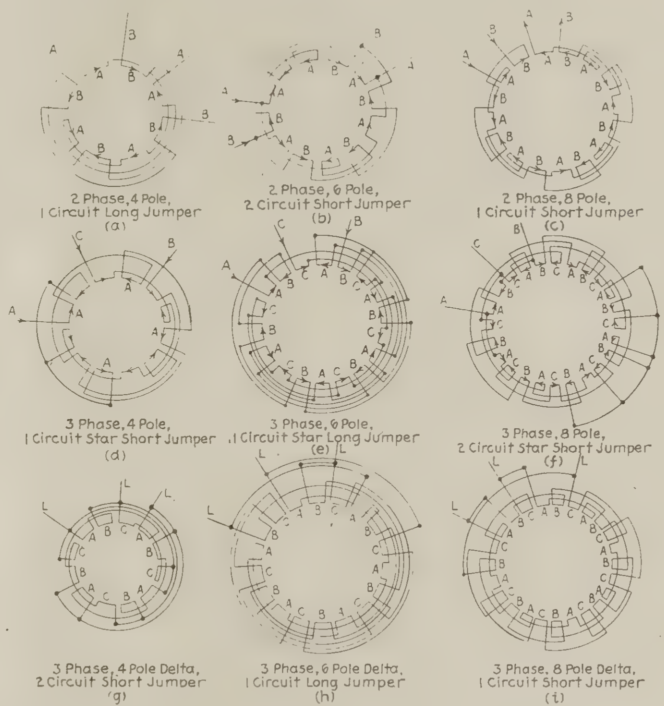


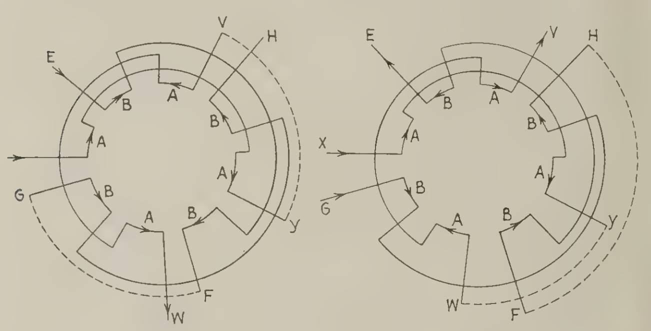
Fig. 110

circuit; long and short-jumper and, in the case of the three-phase diagrams, star and delta connections. With a thorough knowledge of the foregoing diagrams, these will not present any difficulties to us so we shall pass them by without further comment. With the knowledge of winding that we have thus far gained we should be able to construct a circle line or straight line diagram for any type of winding that we should come in contact with.

In the study of our voltage formula we learned that the voltage generated in any given winding depended on, among other things, the number of turns "n" connected in series. In the case of a generator winding the problem is purely one of voltage generation, but it does not appear to be so clear in the case of a motor winding. The problem is, however, exactly the same because a counter voltage nearly equal to the line voltage is generated in the windings of all types of motor windings. Thus a voltage close to 220 is generated in the stator of a 220 volt induction motor. It follows then that if we desire to use this motor on 110 volts it will be necessary that we halve the number of turns in series across the line. Therefore

we should double the number of circuits in the machine. If it were a single circuit winding we should reconnect it to two circuit, if already two circuit we should change it to four circuit. Or, again, if the winding is two circuit 220 volts and we desire to use it on 440 volts it would be necessary to double the number of turns connected across the line; this could be very easily accomplished by making the winding one circuit. By reasoning in this manner we are prepared to meet any condition of voltage change that may come to our attention. It should be especially noted that, regardless of the type of rotor, the rotor winding need not be touched when changing the voltage on which the motor is to operate. This will not seem strange if we reflect that there is absolutely no connection between the rotor and the stator and the stator winding is always so connected that the flux in the airgap remains the same regardless of the voltage. Thus the voltage generated in the rotor at a given speed will be the same regardless of the stator voltage. In passing it might be mentioned that, if we apply the same method of reasoning to rotor windings that we did to the laying out of the stator windings we shall experience no particular difficulty with them.

Our formula will again be found of great help to us if we are considering using a motor on a line where the frequency is different from that on which the motor has been operating. The formula shows that the voltage generated in a given winding depends on the frequency f. Therefore if we desire to use a two circuit 220 volt 50 cycle motor on 220 volts 25 cycles it will be necessary to reconnect the winding to one circuit so that the number of turns across the line may be doubled in order to maintain the same voltage, since the frequency has been halved. Again, if we desire to use a 220-volt two-circuit 25-cycle machine on 220-volts 50 cycles it will be necessary to make the winding four circuit in order to maintain the same voltage on the winding. One point that should be noted, however, is that on a straight voltage change the horsepower of the motor is not changed because the motor is able to dissipate just as much heat as before since its speed has not been changed—the heat dissipated by a given motor depending on the speed at which the rotor revolves, the fanning action of the rotor forcing air through the windings which causes the winding to remain at a safe operating temperature. But when the frequency is reduced the speed of the machine is reduced and the horsepower consequently falls; when the frequency is increased the cooling of the winding is facilitated due to the increase in speed and the horsepower is increased.



Winding Connected for 4 Poles (a) Winding Connected for 8 Poles (b)

Fig. 111

Although, in case of emergency, it is possible to reconnect a two-phase winding so that it may be used on three-phase or vice versa it is not recommended that this be done because the horsepower of the machine and the safety of operation of the winding are both decreased by the process.

Before passing from the subject of induction motor windings it would be well to mention the multi-speed motor. Induction motors are often so wound that they may be run at more than one speed by properly changing the connections of the winding. Usually two speeds are obtained from one winding so that if the motor is a four speed one it will have two separate windings and if it is a two speed motor it will have only one winding.

Fig. 111 shows a two-speed two-phase motor winding. The winding is so arranged that its connections may be made such that either four or eight pole speeds may be obtained from it. Each of the phase windings are divided into two parts, phase A into v-w and x-y while phase B is divided into the parts e-f and g-h. With y connected to v and g to f as in Fig. 111 (a) the winding is connected as an ordinary four-pole one, but when it is connected as in Fig. 111 (b), y to w and f to h all the poles of each phase are connected the same way, all north or all south. This will result in the same number of *consequent* poles so that with this connection the motor will run at eight pole speed. This same method may be used on a three-phase motor. There is only one other point that needs to be mentioned in regard to this winding and that is that if you ever have occasion to wind a two speed motor be sure that the winding is chorded at least twenty percent.

Trains Automatically Light Station

At certain small stations on the Southern Pacific Lines passing trains automatically light and extinguish the station and platform lights. When a train reaches a point from a half to three quarters of a mile from the station, it closes a circuit that is attached to the rail which operation relays and closes an electric circuit, lighting the lamps in the station and on the platform. When the train has passed the station a certain distance it passes over a circuit and releases the relay and the lights are extinguished, thus the lights are always lighted when trains are passing the station.

The Light Is Turned on When the Train Reaches the Point Shown in the Photograph

Night View Looking Eastward From Roundhouse Roof

Lighting the Pere Marquette Yards at Detroit

Flood Lighting Lamps Mounted on Top of Relatively Low Poles Furnish Good Illumination

THE problem of furnishing adequate illumination for railroad yards is being solved in different ways on different roads. The Pere Marquette believes that it has found the correct answer to its yard lighting requirements at Detroit and it is not difficult to appreciate the reason for thinking so after one has observed the night view of the yards from the roof of the roundhouse. The general illumination is excellent and even in those parts of the yard which are located furthest away from the light units, there is sufficient illumination for employees to walk about with no danger of stumbling. Where the work is being carried on there is abundant light for all of the activities which must be performed at night in the coach yard as may be readily appreciated from a close inspection of the photograph. With a few exceptions the flood lighting lamps are mounted as single units on the top of 35 foot poles. A single pole line extends from the west end of the yard to the east, crossing the yard tracks obliquely at each end. At the central portion of the yard the pole line runs along for a distance of about 500 feet parallel to the tracks on the north side. As may be seen from the yard plan the poles are numbered from one to thirty-four, number one being a Bates' batten steel pole located just west of the center of the turntable circle. From this point, the poles are numbered in order to the far end of the east yard, the last pole being number twenty-four. About the center of the yard a line of poles crosses over the tracks at right angles from the north side and these poles are numbered from twenty-five to thirty-four inclusive. With the exception of four batten poles as mentioned, the poles are all of the Bates expanded steel type of construction.

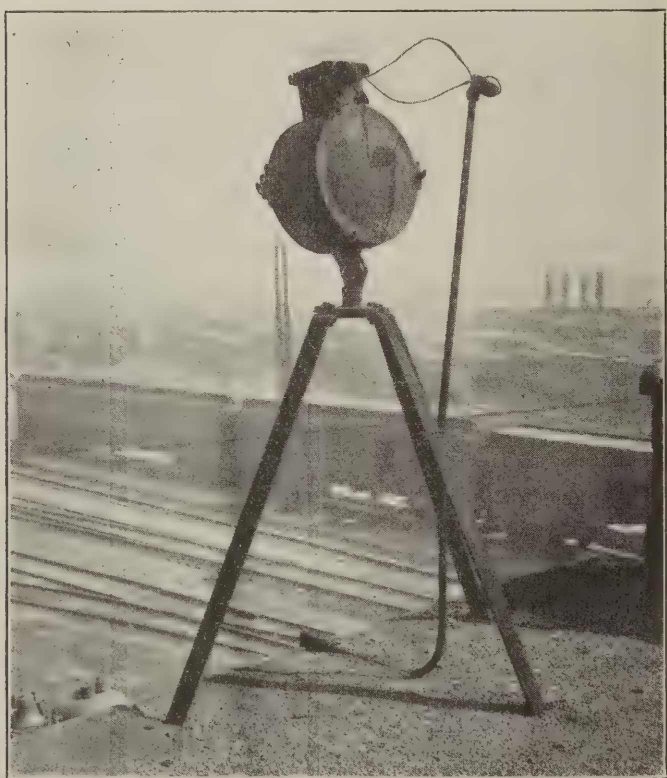
Daylight View of Yard and Buildings Looking Eastward from Roof of Roundhouse

It will be noted that where the line crosses the yard from the powerhouse, short specially constructed poles

mounted on the top of the yard crane structure are employed. Also along the north side of the yard where the line parallels the track there are a number of twenty-seven foot poles. These poles, however, are not used to carry

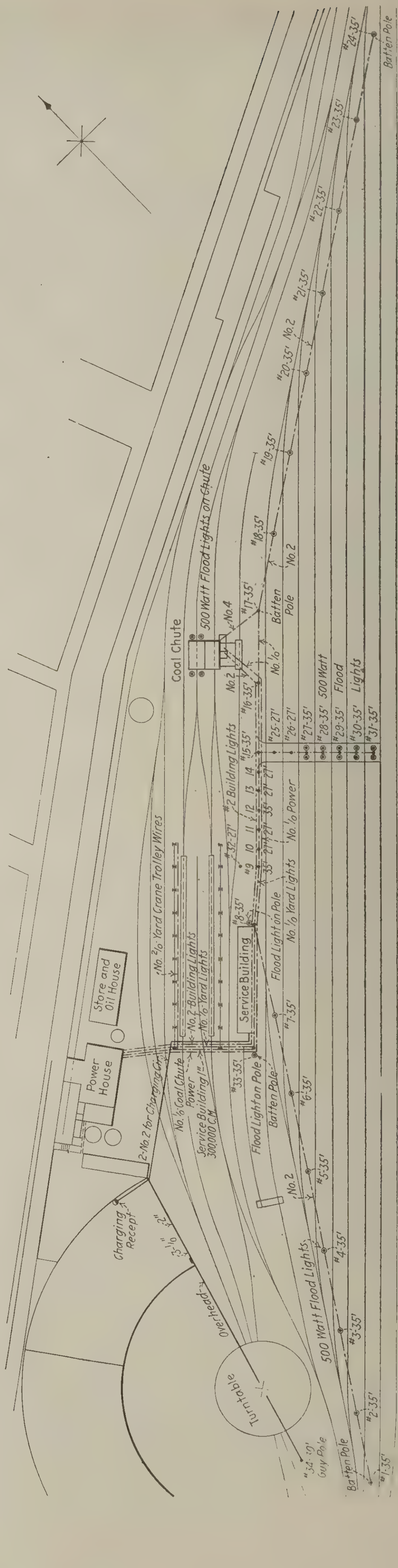
Showing Lines Crossing Crane Structure to Pole No. 33 at West End of Service Building

the circuits but for the purpose of supporting a steam line which enters the yard at this point and crosses eight of the tracks a little further east on poles number twenty-



Arrangement of Wiring and Mounting a Lighting Unit on the Edge of the Roundhouse Roof

five to thirty-one. At points where it is necessary the same poles support both the electrical circuits and the steam and air lines. All of the cross-arms used are made of 3" x 3" x 1/4" angle iron.



General Layout of the Pere Marquette Yard at Detroit Showing the Relative Location of the Tracks, Buildings, Pole Line and Lighting Units

Circuits of Cross-Arms

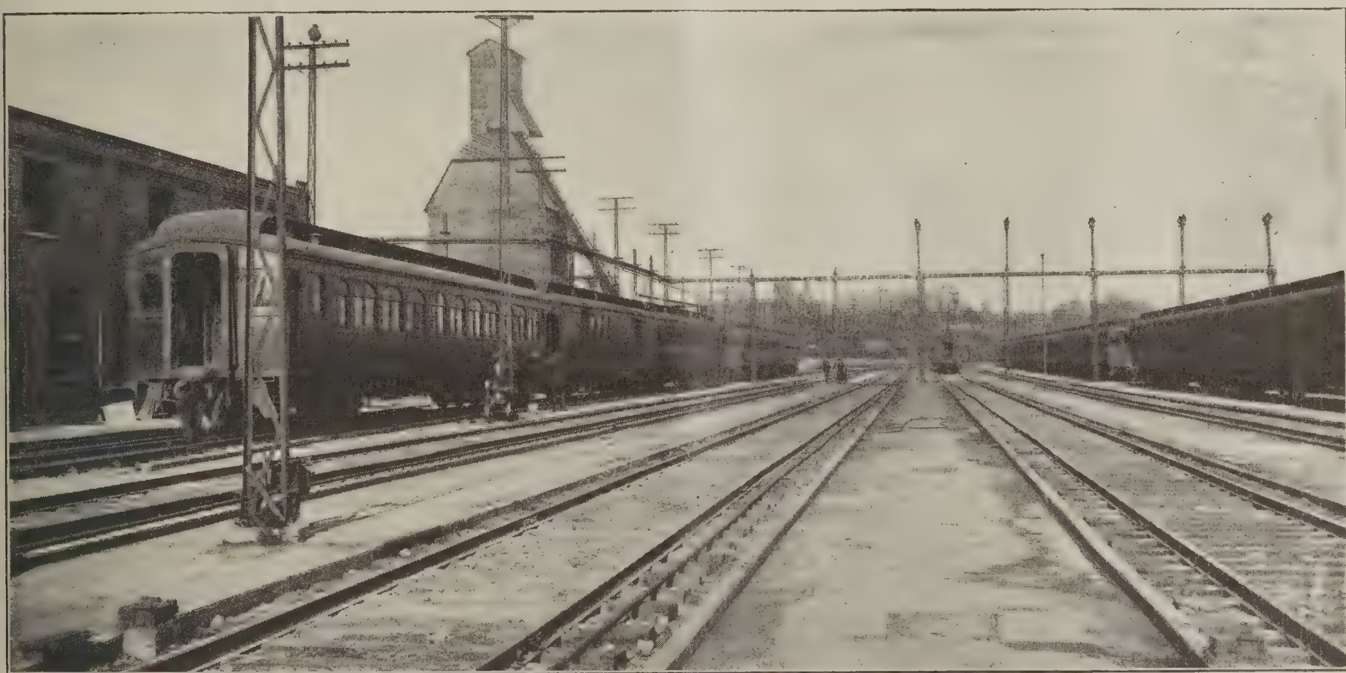
Between the powerhouse and the service plant, the location of which may be seen in the drawing showing the yard layout, the circuits carried on the cross-arms are five in number. Four of these circuits consist of three wires each and one circuit of two wires. This latter circuit runs between the service building and a charging receptacle in the roundhouse where it is used for charging the storage battery of an Elwell Parker truck. This circuit originates at the switchboard of the battery charging plant in the service building. The other four circuits are for building lights, yard lights, service building power and coal chute power respectively. All motor circuits are 220 volt, 3 phase circuits, 60 cycle, while the flood lamps are fed from a 3-wire, single phase circuit using a 115 volt lamp.

The amount of power used for the battery charging plant is so large that it is necessary to run three lines of 300,000 c.m. each from the power house of the service building, but the other lines which require relatively less power are fed through smaller conductors. The building light circuit extends between the powerhouse and the coal chute and uses a No. 2 wire while the power line for the coal chute which is of the same length, requires No. 0 wire. The yard lighting circuit which runs from the powerhouse across the yard and eastward as far as pole seventeen, opposite the coal chute is of No. 0 wire, and from this point to pole twenty-four at the eastern extremity of the yard the circuit is composed of No. 2 wire. The line running between pole seventeen and the coal chute to supply the floodlighting lamps located on this building is comprised of No. 4 conductors.

The line between pole number one and pole number nine consists of three No. 2 conductors.

Lighting Units

The lighting of the yard is accomplished by the use of 500 watt flood lighting units all of which are of Crouse-Hinds design. There are twenty-nine of these units and most of them are located on the top of the poles as may be seen in the illustrations. An important exception to this, however, is found on the coal chute where four of these lighting units are mounted high up on the side of the building, two units throwing their beams in an easterly direction and two in a westerly direction. The flood lighting lamps which are located on the poles from number one to number nine are adjusted so as to direct their beams eastward parallel to the tracks and those on poles eighteen to twenty-four inclusive are arranged to throw their light in a westward direction, also parallel to the tracks. In the center of the yard where the same line crosses the tracks there is a bank of ten flood lighting lamps, five of which are directed eastward and five westward. The turntble pit is lighted from flood lighting lamps located on the roof of the roundhouse. These units are supported by special construction as may be seen in one of the photographs. The general lighting scheme has been admirably worked out and the results that have been accomplished seem to meet the requirements of the yard in a most satisfactory manner. Although all of the actual installatiaon work was not performed by the railroad construction forces, the responsibility for the selection and the location of the equipment rests chiefly with F. E. Starkweather, electrical engineer for the Pere Marquette.



View of Coach Yard from a Point About Opposite the West End of Service Building. Pole No. 7 at the Left in the Foreground

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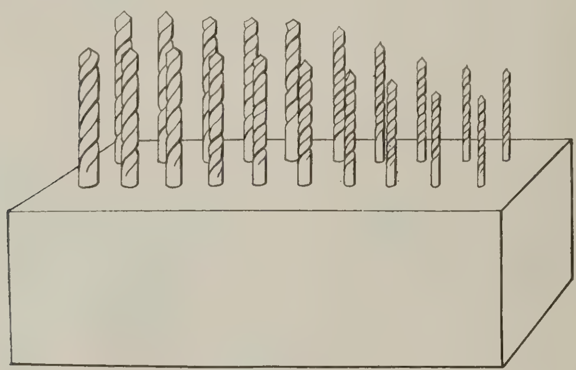
A publication dealing with the theory and performance of small rectifiers has recently been issued by the Bureau of Standards, Department of Commerce. Such rectifiers have come into extensive use in recent years for the charging of radio batteries and other small batteries, and for the charging of larger batteries where a low charging rate is used, this being known as trickle charging.

Three types of rectifiers are described: the electrolytic, the thermionic, and the vibrating. In each case the principles of operation are given, together with results of investigations of their performance made at the Bureau of Standards.

Convenient Rack for Drills

Drill bits of various sizes are difficult to find when kept helter skelter or thrown on benches or in drawers. This treatment also tends to nick the bits and dull them. A handy case where drill bits can be kept in an upright position and separated from each other is very desirable. A simple rack of this kind can be made from a piece of 2 in. x 4 in. lumber and the required length to hold the number of bits. Placing the 2 in. x 4 in. on edge, a hole of the proper size and depth is bored for each bit. It is a good plan to stencil the size of each bit opposite the hole. Such a rack will save considerable time for when bits are kept in a box the one wanted is usually at the bottom of the box.



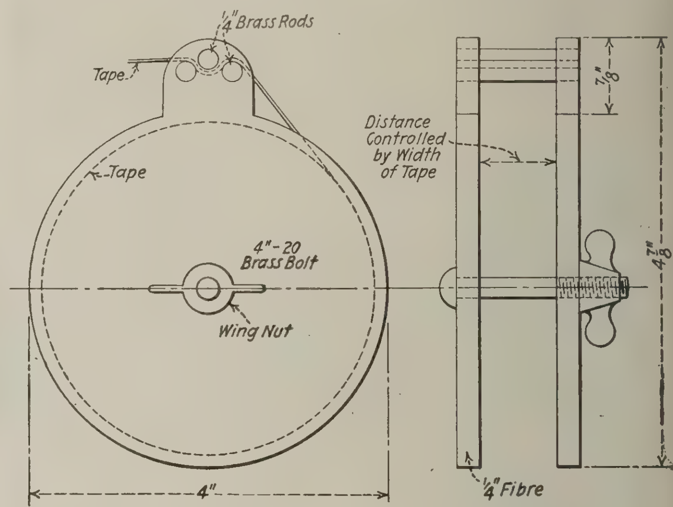
Easily Made Drill Holder

Tape Holder That Speeds Up Work

By E. A. Thurmond, Electrician,
Florida East Coast Railway, St. Augustine, Fla.

The illustration shows a very handy device for taping coils. It is made of 1/4 in. fibre about 4 7/8 in. in diameter with 3 brass rods 1/4 in. in diameter. These rods are threaded on one end and screwed into one of the pieces of fibre, while the other ends of the rods slide through holes of the proper size in the other piece of fibre. By means of a bolt and thumb screw or wing nut as shown, it is possible to adjust the distance between the two pieces of fibre so as to accommodate tape of any width. To prepare the device for use, remove the wing nut and slip off one of the sides. Put the roll of tape on the center bolt and thread the end of the tape through the brass rods on the top as shown, then replace the side and clamp as tightly as desired with the wing nut.

The tape holder is passed around the coils in the same manner as a roll of tape would be, but it is possible to do a much better job and in less time than is required when using tape in the ordinary manner.



Construction Details of Device for Holding Tape

After using this device for a while, anyone can tape a coil with it as quickly as with a taping machine. Armature, stator, transformer and other kinds of coils can be taped satisfactorily with this device.

A Chinese Application

A Chinese newspaper contains the following advertisement for work:

"Sir—I am Wong. I can drive a typewriter with good noise and my English is great. My last job has left itself from me for the good reason that the large man is dead. It was on account of no fault of mine. So, honorable sirs, what about it? If I can be of big use to you, I will arrive on some date that you should guess."

One on Him

A car foreman was having an argument with one of his men the other day. He was very angry and he said, "What do you mean by such language? Are you the car foreman or am I?" The workman replied: "I know I am not the car foreman." The foreman said: "Very well, then, if you are not the car foreman, why do you talk like an idiot?"

Or a Picket Fence

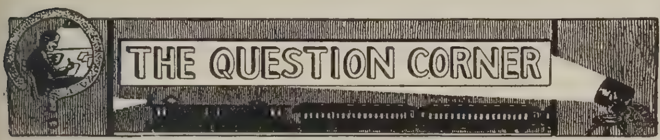
Lee: "Every time she smiles at me it reminds me of a Pullman car at 8 o'clock in the evening."
Leslie: "Howsat?"
Lee: "No lowers, and very few uppers left."

Gastronomic Geography

"Are you Hungary?"
"Yess, Siam."
"Den Russia to the table and I'll Fiji."
"All right, Sweden my coffee and Denmark my bill."

Religious Handicap

Teacher: "Now, Robert, what is a niche in a church?"
Bobby: "Why, it's just the same as an itch anywhere else, only you can't scratch it as well."



Answers to Questions

How can a slide wire type of Wheatstone bridge be made and how is such a bridge used in measuring resistance?

How to Construct a Slide Wire Bridge

An instrument for the measurement of resistance can be very easily constructed from inexpensive material that is usually to be found around almost any electrical shop. This device, known as a slide wire bridge, is capable of measuring resistances between certain limits with a very fair degree of accuracy, particularly the lower resistances. It may be said that its range is approximately between 0.1 ohm and 1,000 ohms. Outside of these limits it is not to be relied upon when close measurements are required.

The construction of the slide wire bridge is exceedingly simple. Fig. 1 gives a good idea of the completed bridge. Upon a wood base 1 in. by 6 in. by 24 in. are mounted strips of brass or copper about 1/16 in, in thickness and ¾ in. in width. These strips extend from *A* to *C*, from *D* to *F*, and from *B* to *G*. They are held firmly to the board by screws. Upon the ends of the strips binding posts are mounted as shown. These posts may be fastened on by screws from underneath the strips or sweated on with solder from on top. The use of screws is probably the best way, and the binding posts should all be attached before the strips are mounted upon the board. Unless the screws are counter sunk in the strip, or if round-head screws are used, allowances should be made on the face of the board so that the strips will set flat against the board when the job is completed.

Between the posts *A* and *B* a piece of German silver wire about No. 24 gage is stretched tightly, and directly under this wire is mounted a double paper scale graduated into a thousand equal divisions with *O* at either end to facilitate taking readings from either *A* or *B*. That is really all there is to the bridge, but a small amount of additional equipment is necessary before the bridge can be used. First of importance are standard resistance units. Three spools at least should be constructed to be used as standards. One of these should have a resistance of one ohm, a second, a resistance of 10 ohms, and a third, a resistance of 100 ohms.

The construction of standard resistance spools is perhaps the most difficult part of the job for the man without facilities for comparing his work with some high grade resistance units. The best wire to use for winding the resistance units is some copper nickel alloy which does not increase in resistance with a rising temperature.

From a wire table which can be obtained giving the

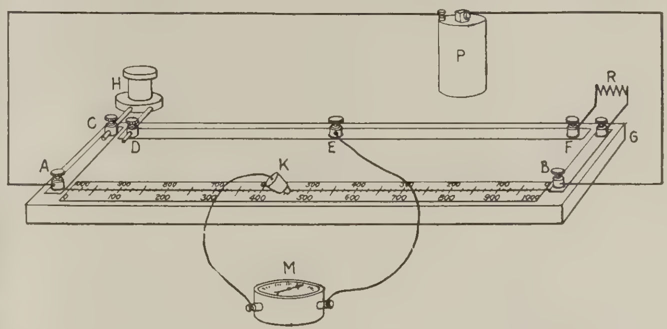


Fig. 1—Slide Wire Type of Wheatstone Bridge

exact properties of the wire used, the number of feet of wire necessary to make any of the resistance spools can be computed.

Fig. 2 shows the construction of such a spool. It will be noted that the wires extending outward from the base of the spool are the ones which fit into the holes in the binding posts *C* and *D* and hence it should be kept in mind to space these wires properly to fit the binding posts. A final precaution should be taken in winding the wires on the resistance spools, and that is to wind it non-inductively as shown in Fig. 2. In other words, just be-

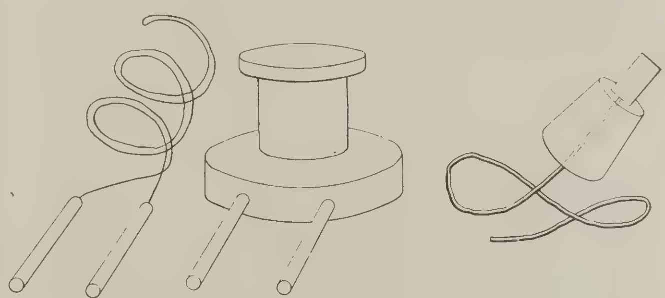


Fig. 2—Non-Inductive Resistance Winding and Spool with Special Contact Making Device

fore winding the wire on the spool, double it back upon itself and begin the winding with the closed or loop end. This will bring the two other ends in position for soldering to the copper terminals.

The slider is made by inserting a copper strip with a flexible wire attached into a common cork.

The galvanometer may be simply a compass needle with a coil of fine insulated wire passing over and under the needle so that the latter will be caused to move when current is passing through the coil. The use of this bridge will be explained next month.

Question for March

1. *How is a slide wire bridge used?*

A New Electric Hand Lantern Battery For Railroad Use

The increasing popularity of the railway trainmen's electric hand lantern has brought into existence a line of new and improved hand lanterns. The National Carbon Co., Cleveland, Ohio, the pioneers in the railway lantern battery field, has completely redesigned its No. 409-C battery, producing an article which is not only novel in construction but is claimed to have longer life and greater reliability than ever before. The new battery is illustrated

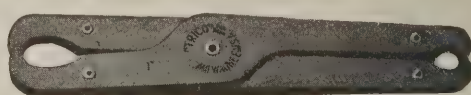
The Flap Which Protects the Terminals from Short Circuit Is Torn Off When the Battery is Placed in the Lantern

herewith. The National Carbon Co. has one of the largest industrial research laboratories in the world, and through its continued efforts the company's batteries are being steadily improved in quality. The carton of the new battery is attractive in appearance, having a varnished surface printed with the characteristic red, gray and blue color design recently adopted by the company. It is so designed that its contents fit snugly, resulting in minimum size and maximum strength and rigidity. The terminal contacts pass through a heavy cardboard cover so arranged as to force the accurate positioning of the terminals and to prevent their being bent or twisted out of place. At the terminal end the battery is provided with a cover flap which passes over the terminals and tucks in at the front. This protects them from breakage and prevents contact with metal shelving, tool boxes, etc., which might otherwise short circuit and destroy the battery. When the battery is about to be put into service this cover flap is torn off.

The internal construction of the battery has also been improved, eliminating the use of the old wooden spacing plug which not infrequently came loose and fell out of place, allowing the battery to lose its rigidity. Also, the unyielding brass connecting strips between cells have been replaced by flexible wire connectors which can withstand vibration and rough handling without tearing loose. In addition to these novel features, the battery is designed with an opening in the bottom which serves as a storage space for an extra lamp bulb or two.

Fuse Puller and Replacer

A pocket tool known as the Trico Fuse Puller and Replacer has been placed on the market by the Trico Fuse Mfg. Co., Milwaukee, Wis. It is 7½-in. long of laminated construction, one half being made of two pieces and the other of three pieces of gray horn fibre. The fibre laminations are riveted together by brass eyelets and forced into an arched position to withstand any tendency to warp. The laminated construction was used in order to make a puller which was stronger in design than one made of



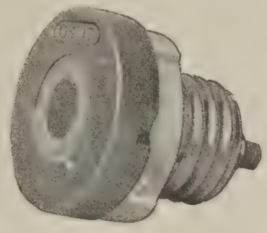
The "Trico" Fuse Puller and Replacer

solid fibre and at the same time to make a puller out of a thin fibre which is inherently stronger than similar fibre made in greater thicknesses. The laminations are individually treated with soapstone to increase the dielectric strength of the puller against leakage, to secure a moisture proof finish and to give the pivot surface a talcum lubricant. Although the device is essentially a pocket tool, its cost is low enough to warrant the placing of the tool in cabinets having a number of fuses requiring occasional

replacements. The puller can be used on all types of fuses up to 200-amp. 250-volt and 100-amp. 600-volt fuses.

Thermal Cutout

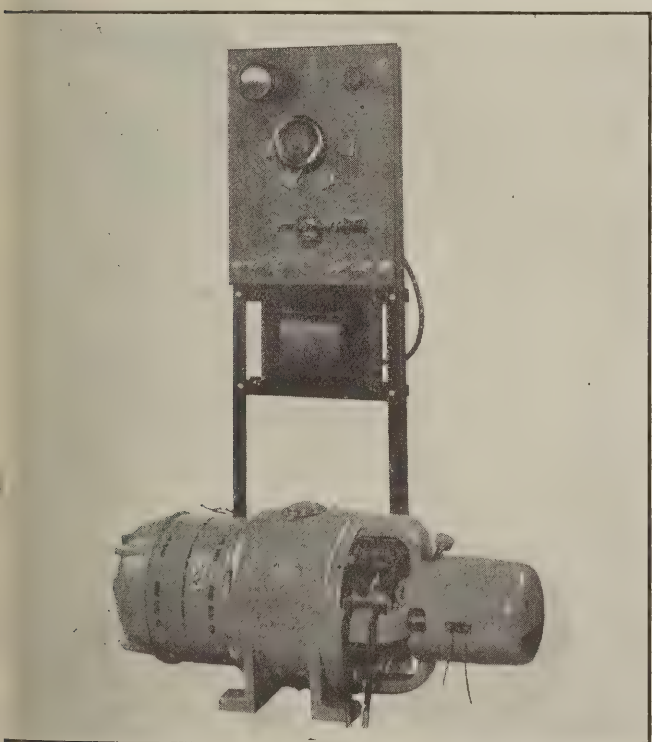
The Condit Electrical Mfg. Co., South Boston, Mass., has brought out a thermal cutout which when used in conjunction with the type N-4 oil motor starter made by that company, is distinctive among protective devices for small motors in that it provides an overload time lag feature. The cutout is designed to give ample protection for motors of 5 hp. or less, operating on voltages up to and including 600. Its characteristics are such that it does not operate on momentary overload or starting, but on sustained overload it operates to protect the motor. The N-4 motor starter is furnished for either 3 or 4 pole service equipped with thermal cutouts.



Condit Thermal Cutout

Rotary Alternating Current Welder

The Allan Manufacturing & Welding Co., Inc., Buffalo, N. Y., has placed on the market in conjunction with its line of welding transformers, a 120-cycle welding generator set which can be operated from any standard supply voltage. The set is designed especially for the welding of cast and malleable iron and is also recommended for the welding of steel.



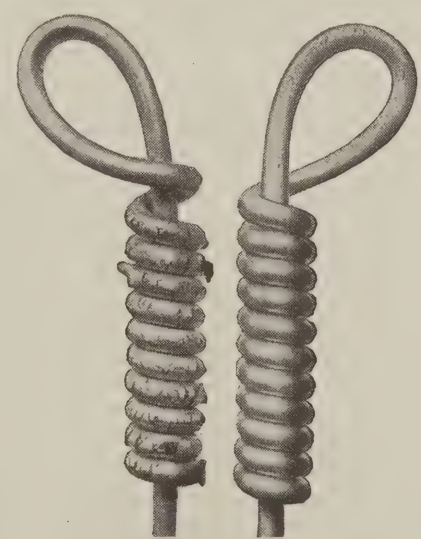
The Allen 120-Cycle Alternating Current Welding Set

The welder consists essentially of a motor-generator set and a control panel. The set when motor driven includes three machines mounted on one shaft. The three machines are an exciter, alternating current generator, and an alternating current or a direct current motor. The machine is also built for belt or direct gas engine drive. The standard machine is rated at 4 kw.

The generator is separately excited having 8 poles for 1,800 r.p.m. and ten poles for 1,500 r.p.m. The generator frame is made of cast steel with laminated pole pieces. Each pole piece is provided with but one coil and all coils on pole pieces are connected in series. The armature is built up on a large diameter shaft and is carried on two ball bearings. An extension of the shaft carries the exciter armature, the frame of which is cast integral with one end bell. When the power supply is direct current, the exciter is eliminated. Aside from the advantages of using 120-cycle alternating current for welding claimed by the manufacturers it is pointed out that the commutator used on d. c. welders is eliminated as a source of trouble and that the set overcomes the objections to the lower power factor of static welding transformers.

New Process of Galvanizing

An improved method of galvanizing known as the Crapo process has been developed by the Indiana Steel and Wire Company, Muncie, Ind. A wire galvanized by this process can be wrapped around its own diameter without cracking or peeling. The essential difference between this process and the ordinary hot-dip process consists of giving the uncoated wire a preliminary treatment in a bath of molten salts before it passes into the zinc bath.



Samples of Old Method and Crapo-Process Galvanized Wire Each Wrapped Around Its Own Diameter

These salts contain carburizing material which leaves its surface in a changed chemical condition.

The wire is drawn to finished size in the usual way and then enters a bath of molten salts where it is immersed for a few moments. Next it passes in continuous process through a washing bath where any adhering salts are removed. Then follows a bath in which the wire is coated with a liquid flux such as dilute hydrochloric acid. From the flux bath the wire passes over a hot plate where it is dried and then into a bath of molten zinc where it receives its protective coating. The wire cools as it passes through the air to the winding reel, where it is coiled in a bundle ready for wrapping and shipping.

General News Section

The Truscon Steel Company is preparing plans for the construction of a fabricating warehouse at San Francisco, Cal., to serve as a distributing center.

The Square D Company, Detroit, Mich., has just purchased an addition to its main plant at Detroit, which enlarges the floor space by twenty-five per cent.

On March 1 the Chesapeake & Ohio began the operation of its passenger trains into Central Station in Chicago instead of the Dearborn street station, which it has used under lease.

The Chicago, Milwaukee & St. Paul has filed a petition with the Interstate Commerce Commission asking an extension of time to July 1 in which to complete the automatic train control installation required by the commission's order of June 13, 1922.

At Nearman, Kan., on February 7, Missouri Pacific passenger train No. 104, southbound, was derailed and its locomotive fell or ran against the engine of a freight train standing on a siding; and both engines were overturned. One passenger and four trainmen were killed and three other persons injured.

Forty thousand is the estimated number of suburban passengers who were delayed for an hour or two at the Pennsylvania station, New York City, on the afternoon of February 6, because of a derailment in the tunnel leading to the Long Island Railroad which blocked the eastbound main track between four and five o'clock for about 20 minutes.

The Gibb Welding Machine Company (successors to Gibb Instrument Company), of Bay City, Michigan, manufacturers of electric welding equipment, announce the appointment of the Welding Service & Sales Company, Donovan Building, Detroit, T. M. Butler, manager, as agents in the Detroit territory for their line of arc, spot, and seam welding machines.

The Electric Arc Cutting & Welding Company, 152-156 Jelliff avenue, Newark, N. J., has announced the opening of its new branch office at Syracuse, N. Y. This office will be completely equipped to handle all sales and distribution of welding machines and supplies for the entire State, exclusive of the metropolitan district. The new office will be under the supervision of William P. McCarthy.

New York, Westchester & Boston has awarded a contract to Dwight P. Robinson & Co. for the extension of this line from its present terminus at Larchmont, N. Y., to Mamaroneck, about 2 miles. The new construction will be double track, and will be equipped with overhead structures for 11,000-volt a.c. electric operation. The cost of the extension will be in excess of $800,000. The Westchester is a subsidiary of the New Haven but will carry out the present work without assistance from the parent company. Extension to Harrison, Rye and Portchester is planned at some future time.

Two robbers succeeded in taking valuables amounting to $10,000 from day coach passengers on a New York Central train entering Chicago on February 26. The two men boarded the train at Toledo, Ohio, and sat quietly in a day coach until the train was passing through Chesterton, Ind., at 8:30 p. m., when they produced a sawed-off shotgun and a revolver, from a suitcase which they carried, and held up a dozen passengers in a Pullman. When the train stopped at Gary, Ind., the men left the train and disappeared.

More Roads Given Additional Time for Train Control Installations

The Interstate Commerce Commission has granted the petition of the Richmond, Fredericksburg & Potomac for an extension of time in which to complete its automatic train control installation to July 1, although this was one of the four roads for which the commission had previously denied an extension. The commission has also granted an extension to July 1 on petitions filed since the first of the year by the Pennsylvania; the Pittsburgh, Cincinnati, Chicago & St. Louis; the West Jersey & Seashore and the Atlantic Coast Line. The Central of New Jersey, which was also one of the four roads denied an extension of time, has filed a new petition asking for a reconsideration and for an extension to September 1.

New York Central Employees Buy Twelve Millions of Stock

The New York Central announces that 41,570 employees have accepted the company's offer of stock in the corporation at 110, which is about $12 per share below the market price. Stock worth more than $12,000,000 was subscribed for. Approximately one employee out of every four on the system is on the list of subscribers and the number of common stockholders is more than doubled. Originally the offer was limited to 35,000 shares but 68,747 additional shares were later added.

All subscriptions for one or two shares will be filled under the allotment plan. Subscribers for three or four shares will receive two shares; subscribers for five to eight, three shares; nine to twelve, four shares; thirteen to sixteen, six shares.

Report on Preliminary Inspection, Chicago & Alton Train Control

The Interstate Commerce Commission has made public a letter from E. H. De Groot, Jr., director of its Bureau of Signals and Train Control Devices, under date of January 5, to W. G. Bierd, receiver of the Chicago & Alton, containing criticisms and comments as a result of the re-

cently completed inspection by the commission's engineers of the installation of the National Automatic Safety Appliance Company's automatic train-stop device on the 22-mile double-track section of the main line between Normal and Chenoa, Ill.

"All Alive in '25!"

This is the slogan of the Safety Department of the Long Island Railroad, as set forth in the latest circular of the department. The discipline and morale of forces of the Long Island having resulted in going eight months, in one year, without a fatal accident to an employee, the fact is characterized as a very good reason for united efforts now to do the same thing for twelve months. Continuing, the circular says:

What do you owe to yourself? "Self Preservation." To your family, the moral obligation of protection to yourself and to them.

The *big idea* for 1925 is one we can all accept—the hope and belief that when the Old Year Passes Out in December, 1925, we can say, *"Thank God, every Long Island Railroad man is still alive!"*

A "Score Board" record of lost time injuries is called for, to be posted conspicuously by each department—and a record kept for each month. Prize for the best record, on a basis of man-hours worked, will be awarded at the close of the year, the particular form of prize to be determined by the General Safety Committee.

Fatal Collision at Manhattan Transfer

In a rear collision of westbound passenger trains on the Pennsylvania Railroad at Manhattan Transfer, N. J., on the morning of Tuesday, February 24, about 9:35, three employees were killed and nine employees and 23 passengers were injured. Train No. 185, the Atlantic Coast Line Express, standing at the station, was run into at the rear by train No. 219, crushing the rear car of the standing train, which was a dining car; and overturning that car and the colliding locomotive. Two men who were coupling hose at the forward end of the standing train were instantly killed and a cook in the kitchen of the dining car was crushed to death, his body somewhat burned, being extricated only after five hours' work. Some of the injured were scalded when the dining car overturned by water from the kitchen tanks. Five of the injured employees were sent to hospitals, but a statement issued by the railroad said that none of the injured passengers required medical attention.

Both trains consisted wholly of steel cars. The locomotive of No. 219 was an electric motor. From train 185 the electric motor had just been cut off.

Five miles an hour is the highest speed allowed within the yard limits of this station, but the locomotive of No. 219 crushed the dining car for 15 ft. or more, indicating that the speed must have been much above the limit.

The dining car took fire, but the flames were soon extinguished with buckets of water. Extinguishers from the station waiting rooms were used, but were not sufficient.

Motorman Joseph A. Keilt and his helper jumped off, and Keilt escaped severe injury. The helper had to go to the hospital. Keilt was indicted on Wednesday on a charge of manslaughter and was held in $10,000 bail. His case will come before the Grand Jury of Hudson County, New Jersey. He made a statement to the effect that he duly applied the brakes, but that they did not check the speed; and the president of the New Jersey Public Utility Commission is quoted as being inclined to accept the statement, conjecturing that the angle cock next behind the locomotive had accidentally become closed. Witnesses are quoted as saying that as the train approached the point of collision the drivers of the locomotive were seen to be locked while on the cars the brakes were not holding.

New High-Speed Line Proposed for Italy

A plan has been presented to the government of Italy for the construction of an electric railway to link up Milan with Turin, and Genoa with Turin and Milan, thus enclosing the great industrial and commercial zone of Northern Italy in a high-speed railway triangle, according to the Times (London) Trade Supplement. The memorandum which accompanies the scheme, after emphasizing the great advantages which Italy's greatest industrial and financial centre would obtain from the projected railway outlines the principal features of the scheme.

It is proposed to run trains at a speed of about 115 miles an hour. The service would be hourly at first, and later on probably a 15-minute service. Thus the journey between Turin and Milan would occupy only 57 minutes, including two intermediate stops. The journey between Genoa and Turin and Milan and Genoa would occupy a similar time.

In addition to the railway it would be opportune to construct a triangle of motor-road between the three centres to afford a rapid means of concentration of passenger and vehicular traffic from inside and outside the triangle. This traffic would feed the railway. Nor does this ambitious scheme stop here. Plans are also included for a similar line to Rome by way of Spezia and Pisa by means of which the journey could be made in four hours, this extension, however, to be carried out after the first lines have given satisfaction. The scheme also contains details as to tariffs and foreshadows some very low rates.

Yale Offers Fellowships in Transportation

The graduate school of Yale University offers annually five Strathcona memorial fellowships in transportation of $1,000 each to qualified students in this field who wish to make further studies. All phases of railway, highway, water and air transportation are included. The holder of a fellowship must be a man who has obtained his first degree from an institution of high standing. According to the will of Lord Strathcona preference is given to persons or sons of persons who have been for at least two years connected in some manner with the railways of the Northwest. Application blanks may be obtained from the Dean of the Graduate School of Yale University, New Haven, Conn.

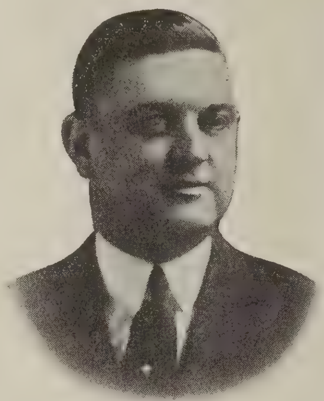
R. F. & P. Again Petitions for More Time on Train Control Installation

The Richmond, Fredericksburg & Potomac, one of the four roads to which the Interstate Commerce Commission refused an extension of time beyond January 1 in which to complete the installation of automatic train control, has filed a petition with the commission for a rehearing. The

petition says the company has a bridge line transferring the passenger and freight trains of six large roads and that therefore it is especially important that it have the best device obtainable. After the commission had authorized preliminary tests of 20-mile sections the company had contracted with the Union Switch & Signal Company on August 11 for an installation between Richmond and Doswell, Va., 20 miles, and expects to be in a position to request a preliminary inspection by the commission some time in March.

Personals

Matt J. Herold has recently been appointed general sales manager for the United States Electrical Tool Company, of Cincinnati, Ohio. Mr. Herold began his business career with this company, working at first during his summer vacations. In 1909 he went on the road for the company introducing portable electrical drills and grinders to motor car manufacturers. In 1910, Mr. Herold left the company and became associated with the sales organization of a large steel manufacturer. This position was held until 1918 when he again made a change, becoming special sales representative with one of the motor car manufacturing units of the General Motors Corporation, as zone sales manager. In 1922 he accepted charge of the east central division of sales for the Wood-Imes Manufacturing Company, of Minneapolis. This position was held until his recent appointment as general sales manager for the same company that he began working for so many years ago.



Matt J. Herold

Trade Publications

Monitor Controller Company, Baltimore, Md., has recently issued a small illustrated folder showing a new heavy current resistence unit known as the Monitor Edgewound Resistor which the company has just brought out.

Engineering Achievements of 1924 is the title of a 52-page illustrated booklet giving in more or less detail the important features of the larger installations which have been made by the Westinghouse Electric and Manufacturing Company during the year 1924.

Electric Machinery Manufacturing Co., Minneapolis, Minn., has just issued its bulletin No. 161 entitled "Synchronous Motors for Pumping." The bulletin consists of sixteen pages and is illustrated with numerous applications of synchronous motors of different sizes.

Herman H. Sticht & Company, New York City, has recently issued its bulletin No. 135, entitled "The Two in One Megohmer." The pamphlet which contains eight pages illustrates and describes the device which is designed to measure quickly and accurately the installation resistance of any circuit.

The Crouse-Hinds Company, Syracuse, N. Y., is distributing two illustrated folders, one of which contains a large number of photographs of Imperial floodlights and projectors, while the second is devoted to the description and illustration of the new "Arktite" circuit breaking plugs and receptacles which the company has recently developed.

The Electric Storage Battery Company, Philadelphia, Pa., has recently issued a 30-page illustrated booklet describing the various devices of Exide batteries used in railway service. The book is divided into three parts. The first part describing batteries in sealed glass jars, the second, batteries in sealed rubber jars and the third, those in open glass jars.

A 60-Ton Oil Electric Locomotive is the title of an eight-page illustrated booklet recently published jointly by the General Electric Company, the American Locomotive Company and the Ingersoll-Rand Company. As the title indicates, the pamphlet describes an oil electric locomotive which is the product of the co-operation of these three companies.

The Bull Dog Mutual Electric Machine Co., Detroit, Michigan, is distributing a four page illustrated folder entitled, "Bull Dog Luminized Safety Switch." The folder illustrates a type of the enclosed switch manufactured by the company and points out the various advantages of the luminating finish which is applied to the device as well as the features which are incorporated in the design.

"Electric Equipment for Cranes" is a General Electric bulletin, No. 48732, recently issued. This is a 35-page leaflet, illustrated with photographs, diagrams, tables and charts. It discusses the subject thoroughly, with particular reference to crane motors and control, brakes, etc. Information is given on operating characteristics and types of standard motors are listed, together with other valuable data.

Veritys, Ltd., manufacturing electrical engineers of Birmingham, England, is distributing their publication No. 961, known as "Maxlume," which is an illustrated booklet of 64 pages devoted to the description of Maxlume reflectors of many various types. Many illustrations are included showing the application of these fixtures. A large number of lamps of various designs are also included in the booklet.

Westinghouse Fittings for Pipe Structures is the title of a 36 page booklet published by the Westinghouse Electric and Manufacturing Company. The publication which is known as Circular 1676, describes these fittings and gives their application to such work as the erection of outdoor substations, switching equipment, switchboard frames, racks, railings, fences, etc. It contains an unusually large number of photographic illustrations, supplemented by dimensional drawings, making the publication useful as a reference book for the designer of such structural work. An adjustable insert for fastening machinery or other equipment to concrete floors, walls or ceiling, another new Westinghouse product, is also described and pictured in the publication.

Railway Electrical Engineer

Volume 16 APRIL, 1925 No. 4

Indexes for Volume 15 of the *Railway Electrical Engineer* are ready for distribution. Some time ago we discontinued the practice of publishing these indexes with the magazine, but they are available and can be secured by addressing a communication to the *Railway Electrical Engineer*.

Indexes for 1924

New Coaches for the Lackawanna

The new steel coaches recently purchased for the Delaware, Lackawanna & Western differ considerably in appearance from other equipment operated by that road. The outstanding feature is the reduced head room, although it cannot be said that this feature has been carried to the extreme. There is no reason to assume that the cars will be uncomfortably warm in summer as they are abundantly supplied with ventilators.

The lower ceiling does, however, perform one function most admirably and that is, it increases the illumination of the reading plane. Bringing the lighting fixture nearer to the passenger means unquestionably more light on the reading plane, and for this reason, if for no other, the cars are bound to meet with favor.

In designing the lighting of these cars recognition has been taken of the fact that there is a probability of their being eventually used for electric operation, and when such time arrives the axle generators will not be needed. The design of the body and underframe also is such that the cars may be easily transferred to and arranged for operation in multiple unit service. Other interesting details in connection with these new Lackawanna coaches may be found in the article on page 99 entitled "The Development of Car Lighting on the D. L. & W."

Radio on Trains

Communication between the head and rear end of long freight trains is now being experimented with, and it is highly probable that it will become an established part of train operation in some districts. The type of equipment now being experimented with consists of combination sending and receiving sets, one of which is mounted in the cab of the head end locomotive and the other in the caboose or pusher locomotive. Pulling a cord, which hangs from the set, signals the other end of the train with a whistling sound and when the cord is released, conversation may be carried on by telephone. In case the telephone is unsatisfactory, or unnecessary, whistle signals are transmitted by using the call signal cord.

During the past four years practically all applications of radio to moving trains have had to do with the receiving of broadcast programs on passenger trains. Radio will probably be applied in this way all over the United States. It has a wide popular appeal as an amusement and its advertising value, coupled with the competition of railroads to give best service, will almost surely cause it to be used on many of the higher grade trains making long runs. All through trains on the Canadian National are already equipped with receiving sets, and broadcast stations have been established at different points along the line.

Most of the broadcast receiving which has been done on moving trains has been put in effect by the electrical men who are affiliated with the mechanical department. This has been a natural development because these men have looked after all electrical apparatus on cars and locomotives. The case is not quite so clear as applied to sets on the head and rear end of trains as this practice involves both signals and communication. It is an electrical application, however, and its installation and maintenance will probably fall to the men in the electrical department who are most familiar with this class of apparatus. Radio is one of the several opportunities which have recently presented themselves to the electrical man, and he should use it to the best of his ability.

More Car Lighting Articles

There is no dodging the fact that many of the readers of the *Railway Electrical Engineer* are interested in car lighting. We have found that out in many ways, one of the principal ones being complaints which we have received in the past that there was not enough car lighting material to be found within the covers of the paper. It may be that we have been somewhat remiss in not publishing more articles on this subject, but to those who have censured us in this respect we wish to point out the amount of material on this subject in the last four numbers; moreover, we are taking special measures to insure more articles on car lighting in future numbers.

It must be remembered, however, that car lighting today has quite a different aspect from what it had when the *Railway Electrical Engineer* was founded. In those early days about the only activity for the electrician on any steam railway was car lighting. Moreover, car lighting was just being developed and there was no end of material to be had concerning the various types of equipment and the troubles and trials of car lighting men in general. Today it is altogether different. Car light-

ing practice has become largely standardized and it is only here and there that differences crop out which are worthy of record. If you are doing something different in car lighting from other roads we should be very glad indeed to hear about it. Don't keep it to yourself. If you have found out something worth while the chances are that others will be interested in hearing about it. Tell us about your car lighting practice and the *Railway Electrical Engineer* will tell the car lighting world about it.

Letter to the Editor

The C. M. & St. P. Electrification Report

TO THE EDITOR:

The study of comparative costs of steam and electric operation on the Chicago, Milwaukee & St. Paul in the March issue of the *Railway Electrical Engineer* is of great value to all students of the subject. The management of this railroad is to be thanked for making it public, and the *Railway Electrical Engineer* for its comprehensive presentation. It is probable, however, that few railroad men can give to any such analysis more than a casual reading without finding details in which there appears to be a bias in favor of one method of operation or the other.

In any such comparison between two systems of operation, one pre-existing and the other substituted, or proposed to be substituted, two methods of comparison offer themselves: (1) comparison between the existing system (steam) with the existing equipment of old apparatus, purchased at the lower prices of former years, and the new system (electric) with a complete outfit of new equipment; and (2) comparison between the existing system, assumed to be supplied with a complete outfit of new and up-to-date equipment (with all that that implies of increased efficiency and conveniences) and the new system similarly equipped. The second method of comparison is generally of purely academic interest, for there is seldom a possibility of substituting on a road or division a complete new outfit of steam locomotives and new and newly located shops, engine houses, and auxiliary facilities.

The St. Paul estimate seems to be a mixture of the two methods of comparison. The steam operation is charged with the pre-existing locomotives, not at actual cost or at depreciated book value, but at 1918 prices.

Presumably steam locomotives purchased in 1918 would have been more perfectly adapted to the road and traffic, and more efficient and economical than the pre-existing locomotives. Yet the steam operating costs are computed not at the reduced rates which might be assumed to exist with the assumed outfit of new steam locomotives, but at the rates due to the old, less efficient equipment. The same line of reasoning applies, to a less degree, to certain other items.

Again, it is open to question whether in such a comparison the steam operation should, in such items as engine houses, coaling and water stations, cinder pits, etc., be burdened with more than the salvage value of these facilities after abandonment. If the estimate is to reflect truly the effect on the treasury, the difference between the steam and electric interest items should equal the increase in annual interest payment, and to secure this result the interest for steam operation should be computed on such a sum, only, as the treasury would receive as the result of the abandonment of the facilities. If a $50,000 water plant, for instance, has to be abandoned, when the division is electrified, with a salvage of only $10,000, the treasury is relieved to the extent of only $10,000, not $50,000. If a particular $50,000 of bonds could be allocated to that water station, obviously $10,000 of the bonds could be redeemed from the proceeds of the salvage, but the interest on the remaining $40,000 would continue. This criticism has little application to locomotves, because of their ready transfer to other divisions, but may apply to certain other items, possibly to the d. c. signal system, which had to be replaced by a. c.

In most electrification comparisons the saving due to the discontinuance of the line haul of locomotive fuel is a large item. In the present comparison, arranged according to I. C. C. accounts, this item, of course, does not directly appear. While data as to source and routing of fuel are lacking, it seems probable that the saving on haul of the $1,200,000 worth of coal in Table II might amount to some hundreds of thousands of dollars per annum. No such large reduction in transportation costs (other than those naturally to be expected due to reduction in number of locomotives and other effects of electrification) appears in the table. An analysis of this item would be of great value for future electrification estimates. It seems fair also to assume that some of the locomotive fuel used on the divisions represented in Tables II and III was hauled on other divisions; if so, there appears to be no allowance made for the cost of such haul.

Probably most steam men would examine with much interest the details of the argument whereby four electric yard locomotives supersede ten steam locomotives, if equally efficient and intensive operation be assumed.

It would be interesting to know whether the rate 6 per cent at the head of the Depreciation column of Tables IV and V is the rate of depreciation, or the rate of sinking fund earnings, and, if the latter, what rates of depreciation were used on the various classes of equipment.

ENGINEER.

New Books

Electric Design of Over Head Power Transmission Lines—By Wm. E. Taylor and R. E. Neale, 260 pages, diagrams and tables, 6in. by 8½ in., bound in cloth. Published by D. Van Nostrand Company, New York. Price $6.00.

The book is a systematic treatment of technical and commercial factors with special references to pressures up to 60,000 volts and distances up to 100 miles. The effects of capacity, skin effect and corona are discussed quantitatively so that the reader may confirm that these effects are of negligible importance on secondary transmission lines. None but the simplest mathematics is employed and special care has been taken to state units of measurements. The formulas and diagrams are immediately applicable to the numerical solution of an actual problem, and wherever possible numerical examples have been included in the text to illustrate definitely the methods and qualities concerned. The book is divided into nine chapters and the subject matter treated is as follows: Transmission systems and circuit relations, standard data for conductor materials, general formula for area and weight of conductor, power factor and power factor correction, alternative basis for line design, impedance and power loss calculations and charts, weight and cost of conductors, design of transmission lines and minimum cost, and transmission lines compared.

D. L. & W. Suburban Coach

Development of Car Lighting on the D. L. & W.

Difficult Conditions of Suburban Service Have Been Successfully Met With Axle Generators of Ample Capacity

By George Wall
Car Lighting Foreman, Delaware, Lackawanna & Western R. R., Hoboken, N. J.

ELECTRIC lighting of passenger cars in suburban service in congested sections, served by steam railroads presents a very different problem for the car-lighting department than does the lighting of cars in through service. In some respects it is an easier problem; in others, very much harder. The continual vigilance required on the part of the maintenance forces to keep generator output a little ahead of requirements, due to excessive burning hours and losses of various descriptions, taxes the resources of those engaged in the work to the limit.

On long runs, in through line service, the running time is usually ample to permit of the equipment furnishing all the current required for lights and battery charging, provided the generating apparatus is maintained in good serviceable condition.

Short periods of burning when passing through cuts, tunnels, depressed section of roadbed, makes no serious demands on the equipment on the average long run, and the margin of output over requirements is usually able to take care of the demand without trouble. In fact, the greatest amount of effort has been expended in designing equipment to regulate accurately the output, keeping it down to a point where excess current is not allowed to seriously injure the battery due to overcharge.

Suburban runs are the direct opposite of the foregoing in that the running time in terms of output is barely sufficient to maintain the light and to charge the battery properly on some runs, while on others the possibility of too much current output must be guarded against. The fact that a car may operate on a "good run" for one day and a "bad run" the next day is what makes the problem more difficult. If economy and efficiency receive proper consideration, the equipment must be so regulated that neither overcharge nor undercharge will result under normal conditions and cars are free for service to any point desired by the operating department. Runs of ten or twelve miles with stops a mile apart or less are common; the daily burning hours are apt to be even longer than the average for through service; bridges and depressions which are usually found in congested territory add their quota to the total consumption, and the peaks of travel in the morning and evening rush hours come at a time when the cars must be lighted, usually for the entire trip. Many other items contribute to the lengthening of daily hours of burning such as yard cleaning, interior cleaning in the coach house, busy train crews who allow the lights to burn unnecessarily while collecting tickets, or in yards while waiting for their runs to start.

That the difficulties are not insurmountable is, of course, proved by the fact that numerous roads are electrically lighting their cars in such service and furnishing adequate illumination for the purpose.

Some roads have gone in for special equipment, designed to give full output at low train speeds while others are using the same equipments as used in through service, and by changing the control adjustments, have taken care of the requirements of the service. It is very evident that conditions vary greatly on different roads, as success is attained by both methods. Each road must decide for itself what is necessary to provide for its own particular conditions and interchange of ideas and discussion of methods with other roads is mutually beneficial.

In 1912, the Lackawanna first started seriously to consider lighting their suburban cars by electricity rather than by Pintsch gas acetylene. This year also marked the advent of the steel car in this class of service. At that time there was very little information available as to the best method and equipments for this service, so it was decided to install standard equipment and by in-

creasing pulley ratio bring the cutting in and full load speed down to considerably lower figures than those prevailing in through service.

These original installations consisted of 3kw. truck hung, sleeve bearing generators of 300 ampere hours capacity, lead plant battery, 16 cells each; generator and lamp regulation. Train lines were also provided on each car. Center lighting fixtures were installed, as well as one platform lamp on each end and a toilet light. The G-30-30V-50W clear lamp was used in the center lamps and the others were G18½-30V-25W clear lamps. The interior finish was dark oak with dark green plush seats and green head lining. All fittings were oxidized finish.

It was thought that this installation amply provided for the work expected of it and the cars were put in service early in 1912. At various times new cars were added and at the present time about 350 cars are operated in this service. Various changes have been made in succeeding installation from time to time as experience gained from actual service proved advisable.

In the first series of cars built in 1912, center lighting was employed as previously stated, the 30V-50W-G30 lamp was used with an enclosing bowl with a large hole at the bottom to permit of replacing lamps and allow of easy cleaning without removing the bowl from the fixtures. The generator regulator, lamp regulator and switchboard were mounted in a cabinet at the end of the car on the opposite side from the toilet. The switchboard was a two circuit panel with battery main light and train line switches. The cabinet was divided into two parts, the upper section containing the switchboard and the lower the two regulating panels. The door to the switchboard section was equipped with a spring latch while the lower section was locked with a yale cabinet lock to keep out unauthorized persons.

The center lights, nine in number, were all carried on one switch and the platform lights, one in the center of each platform, and the one toilet lamp on the remaining switch.

The cars were equipped with train lines consisting of two wires, No. 2 stranded, with a capacity of 90 amperes.

The wiring, so far as possible, was run in conduit laid along the center of the roof on top of the car, supported one inch from the roof on wood blocks. All wiring under the car was run in conduit. The fittings consisted of cast iron boxes, drilled out to admit the required size of conduit.

The battery consisted of 16 cells, lead Plante type, approximately 300 amp. hours capacity, assembled in eight double compartment lead lined trays. The battery box was of steel, wood lined throughout, with the usual vents in the doors and bottom of the box.

The drive was by means of a 5 in. 4-ply rubber covered belt running on a pressed steel axle pulley 8 in. face straight flange, 22 in. diameter, with a cast iron bushing inside the standard 7½ in. hub, and a 9½ in. armature pulley with a 7 in. face, perforated. There was no particular belt clearance problem as the trucks were of the open end type with inside brake beams. The brake beams, however, were not the usual type, a special diamond shape beam having been designed to allow of clearance for the larger axle pulley.

In 1915, another series of cars was put in service and the lessons learned from the first equipment were applied. These cars employed the same equipment as the first as regards capacity of the generating apparatus and battery. The truck suspended generator was retained, but the suspension was of the bushed type providing means for easily and cheaply repairing worn parts. The ball-bearing was now coming into general use and was adopted on these cars.

The greatest departure from the previous cars was in illuminating conditions. It was evident very shortly after the 1912 installation that center lighting using the G30 lamps with 6 foot spacing did not meet the growing demand for better lighting on the part of the commuter who was now complaining about gas and electric lighting impartially. The center lighting was greatly handicapped in getting light to the reading plane by the height of the fixture and the dark finish of the interior which absorbed a considerable percentage of the light instead of reflecting it.

To help conditions, the finish of the headlining was changed to a much lighter color and side lighting fixtures installed. In order to provide clearance between baggage rack and lamp shade, bracket fixtures were used. Lamps were 30V-25W-G18½ clear with an opal glass reflector. A very considerable increase in light on the reading plane resulted and the car presented a more cheerful appearance as rattan seats had replaced the plush covered ones and the dark oak finish was changed to light mahogany.

Changes in the conduit location were necessitated by the different lamp locations and, while the circuits were still two in number, the lamps were equally divided between them, each switch carrying alternate lights. The circuits for the lights were run in concealed conduit along the inside of the deck which made access for repairs considerably more difficult. The train line conduits were run between the headlining and roof sheets and extended from one hood to the other in an unbroken line, a considerably better proposition than placing it on the outside of the roof.

From 1915 to 1920, the influence of the war and the bending of all energies toward its successful prosecution, left little time for new developments in car lighting. During the period mentioned, the only change was to adopt body suspended generators and the 18 in. diameter, 10 in. face, flare flanged axle pulley, and 8 in. flare flanged armature pulley changing the pulley ratio to 2.25:1 from 2.32:1. The rest of the installation remained as in 1915.

The adoption of body suspended generators was prompted mainly by consideration other than the requirements of maintenance of the electrical equipment. Up to 1918 no major replacement of suspension parts had been necessary, as very little wear was noticeable, and what little there was only resulted in the pulleys getting out of alignment. Attention to the aligning screws adjusted the matter. Body equipments were used in through service, but were not driving the load as satisfactorily as the truck machine. Belt stretch was greater and more slippage in bad weather seemed to outweigh whatever advantage might be shown in other ways. At this time, however, the trucks of the older cars began to show the effects of constant hammering of the unsprung weight. Pedestals, equalizing spring and wheels on the generator truck gave more trouble and generators in several instances, which had 4 in. clearance from the center girder while the car was standing still, fouled the

girder at times, when crossing switches or poor rail joints. Repairs necessary to trucks in order to stop the fouling which would in time cause breakage of the side hangers were expensive and required that the car be cut out of service, a very undesirable feature when there was shortage of cars. Wheel records show that axle pulley wheels developed sharp flanges and worn treads quicker than the other wheels by a ratio of almost four to three. In other words, the mileage of pulley wheels was about 25 per cent less than the average for the other wheels. Evidently, economy demanded that generators be placed on the body under these conditions. There is no economy shown in the performance of body over truck suspension from the standpoint of maintenance of the generator, suspension and drive. The largest items of equipment maintenance cost are the belt and pulleys. An immediate

Location of Generator on Suburban Coaches

increase in belt cost of approximately 50 per cent, coupled with lower mileage per belt is not offset by economies made possible by body mounting, provided, of course, the comparison is made between the best type truck suspension and ball bearing generator and the body suspension with the same type generator. In suburban service, the belt life is determined in terms of its actual wearing qualities and ability to withstand the natural deterioration due to age, to a greater extent than is the case in through line service. The mileage per month averages less than 30 per cent of through line mileage and most of the time the suburban belt simply remains idle, subjected to the action of the elements, without having to drive its load. The combination of drive and exposure finishes the average through line belt in about four months, while it is common for suburban belts to last upward of two years, during which time they may travel an average of 2,500 miles per month and this at a lower average train speed with more uniform weather conditions, road bed, etc. The average mileage for suburban belts runs around 65,000 miles, due partly to the fact that the suburban car is under the inspector's eye almost daily and the belt is allowed to run until it falls off. It is of no particular value, even as scrap, and the limit of service is taken by letting it run itself out. In fact, as soon as belts on through runs show that they are not dependable for further service they are removed, repaired and used on suburban cars to finish out their life.

The year 1920 marked a revision in one important particular, namely, center lighting was again resorted to as the most satisfactory location. Center lighting, in spite of numerous advantages, failed in the main requirement of giving adequate light on the reading plane on account of the lack of a lamp of sufficient candle power. Side lighting brought the lamp much closer to the passenger, and by doubling the number of outlets, the 25-watt lamp provided considerably better lighted cars with a given wattage.

Side lighting has disadvantages. The initial installation is complicated more than center lights, the doubling of the fixtures and glassware is a disadvantage in cleaning and maintenance, breakage of glassware is very much greater due to proximity to the baggage racks, more dirt lodges on the fixtures as it is just under the ventilators and the cost of replacements totals more than with center lighting. Side lighting held its place only by virture of its ability to give better illumination on the reading plane with the light source available. The appearance on the scene of the train lighting type "C" lamp in the 50 watt, PS-20 size changed conditions immediately. The old cars which had the center lights were equipped with these lamps, and without any increase in consumption of current, the lighting of the cars was brought up to a par with the side-lighted cars although the center light still had the decided disadvantage of dark surroundings to overcome. This lamp made it possible to secure all the economical advantage of center lighting and good illumination as well. Since this lamp became available all 50-watt lamps of the "B" type have been discontinued, with gratifying results. The "C" lamp does not fall off in candle power as the impressed voltage drops, as rapidly as the "B" lamp. On the other hand it will not withstand high voltage as will the "B" type. Low voltage cannot be entirely eliminated, but properly operating lamp regulators will curtail excess voltage so that very few lamps will fail from that cause.

It has been proved in this service that a surprisingly small percentage of the lamps are removed because of ruptured filaments or blackened bulbs. Other causes such as accidental breakage when cold, careless handling by cleaner as well as plain theft account for the loss of a very considerable number of lamps. The advent of country home lighting outfits using the same voltage has put the car lighting lamp in practically the same position as the umbrella which never stays with its owner long enough for him to get his dollar's worth. As the foregoing covers the main point of the various installations up to 1925, it is interesting to note the changes and improvements incorporated in the layout of the latest type cars just put in service.

These cars were designed to permit the installation to multiple unit propulsion current apparatus at some future date if desired at a minimum of expense and reconstruction.

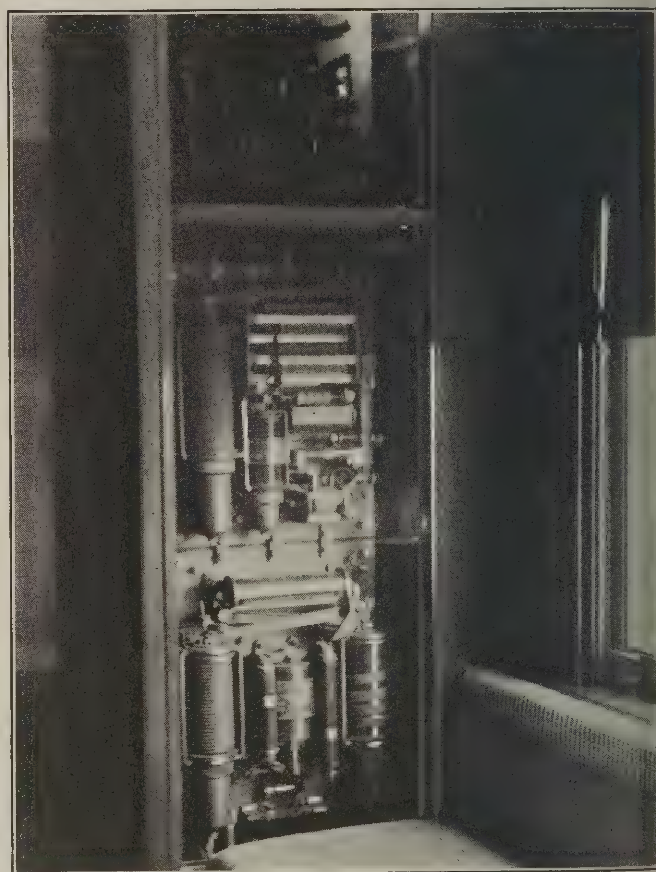
The equipment consists of a 3 kw. 30-40 volt, ball-bearing, body suspended generator driven by an 18 in. axle pulley, 10 in. face, flare flanged, and an 8 in. armature pulley also flare flanged being the same in this respect as the cars built since 1920. The slight raising of cutting in and full load speed due to the change in pulley ratio has proved but a slight handicap and the belt clearance problem is simplified, particularly as the truck

is now equipped with clasp brakes necessitating an outside beam and an end-sill and over the brake beam. Clasp brakes were first used on cars built in 1915 and, when new, the belt clearance was at least 3 in. over both end-sill and beam. However, due to the changes in clearance brought about by wear of trucks and wheels, settling of car body springs, etc., on a considerable number of cars the belt clearance over the brake beam eventually became as little as 1 in. which is entirely too limited for body hung equipments. Fortunately, the matter is easily adjusted by putting a 1 in. to 1½ in. offset in the brake beam which is of flat bar stock 4 in. horizontal dimension by 1 in. thick.

The regulating panels of the new cars are of the same capacity as those previously used, but of course all refinements and improvements are incorporated in these panels such as compensated coils, air dash pots, etc. The cabinet is the same as on the first cars and each car is equipped with train lines and a standard 2 circuit switch board. However, the conduit wiring and distribution has been changed somewhat to conform with latest practice.

The lighting layout has been changed in but one particular and that is each platform has two flush fixtures whereas the first car had but one fixture which was simply a flush socket which left the lamp exposed. As these cars are very much lower than the previous standard it was necessary to use a center fixture with less drop than those previously used. But the same enclosing bowl and lamp are used and the same number of fixtures. Due to the lowering of the lamp the light on the reading plane is tremendously increased and now far surpasses any of the previous installations in this respect. At the suggestion of safety committee the original platform open lamps were shaded by the addition of a metal reflector. Engineers said that the exposed lamp was objectionable as it tended to obscure the marker lamps and might cause trouble due to confusion of colors at night. The reasons for using two platform lamps are two, one being that no change will be necessary in the event of multiple unit operation, and the other and more present one was that the single lamp was placed in the center of the platform and when passengers were alighting at a station a deep shadow was thrown on the steps as the passenger's body was between the light and steps. If the car happened to stop so the steps were not lighted by a station light it was quite difficult for the descending passenger to see them clearly and the possibility of a fall with danger of serious injury was increased. The use of two lamps practically eliminates this possibility as the steps are well lighted and no shadow is thrown on them by the passenger in his exit. This fixture facilitates unloading with safety, a very desirable condition during rush hours when trains run under slight headway and every minute counts.

Due to the present practice of concealing the conduit, it has been found desirable to run the train line circuits and lighting circuits in separate conduit lines. It was quite satisfactory when the conduit was exposed on the roof, to use one conduit to carry both circuits. As the roof boxes were spaced only about six feet apart, access to the wiring was a simple matter by removing the outlet box cover. In case of trouble, it is quite easy to pull out the six feet of wire between outlets for repair or replacement and the position on the roof made a small job of it. However when the wire had been in the pipe some time and the conduit subjected to the direct ray of the hot sun, the impregnating materials used in the braid covered wire became very soft and sticky. On cooling, the compound hardened, but all the wires in the conduit were tightly held in place as if they were cabled together. It became quite a job to remove any part if desired. On the roof, however, it was fairly easy to get leverage enough to pull the wires loose and any damage done to paint or roof is easily fixed up again by the application of some red lead and roof paint. When the conduit is concealed, these wires can only be reached from the inside and fixtures must be taken down to provide access. When the job is finished, the car is about ready for the shop to refinish both fixture and headlining. With only the circuit wires to remove the matter is simple and easy and there is no excuse for mussing up everything in sight. Train line wires seldom, if ever, give trouble, at least the portion in the conduit and the conduit may



Regulating Panels Are Located Just Inside Vestibule Door and Flush Against the End Seat

run in an unbroken line from hood to hood. It costs a little more in the initial installation, but the ease of maintenance makes the added outlay worth while. Another point in the wiring and conduit scheme where improvement is made is at the battery box. Where the wires enter each end of the battery box, a conduit fitting is placed and the braided wire ends at this point, the circuit being completed to the set terminals with ordinary rubber covered battery connector wire of the same carrying capacity as the remainder of the circuit, with a suitable terminal provided for the connection to the battery terminals. If the braided wire is run with the battery box and, as was the usual practice, a brass or copper

terminal used, an unsightly sulphated terminal lug shortly resulted and unless frequently inspected and renewed, a very troublesome connection was provided. Lead plating is of no value at this point as the acid makes short work of the plating and later the terminal. The plating is cut through after tightening up the connection once or twice and is no protection after a short time. The use of the tough rubber covered wire with a lead terminal practically eliminates this source of trouble. The short nipples of conduit running from the conduit fitting through the end of the box should be further insulated from the rubber covered wire by slipping a piece of loom or fiber over

Interior of the New Type Suburban Coaches

the wire and pushing it through to the fitting. This method has entirely eliminated trouble between battery and switch board and makes the use of battery box fuses less necessary. Our experience with these has been that they are a continual source of trouble and more dangerous and troublesome than the fire hazard they are supposed to eliminate.

The center lights are divided into two circuits, every alternate lamp, five center lamps on one circuit; four center, four platforms and the toilet lamp on the remaining circuit. Two circuits are sufficient, the main advantage of splitting up the load being in the event of a short circuit. If properly fused and connected up, trouble on one circuit does not affect the other one which gives fair illumination until the terminal is reached and proper repairs made. More than two circuits are not particularly desirable as all lights are required when the car is in service with the exception of daylight runs when half lights are sufficient for the short time that trains are passing through cuts and tunnels.

The interior finish of the car offers a much better reflecting surface and is a very decided improvement. The light cream head lining and fixtures painted to match are pleasing to the eye when under observation. There are, however, no sharp contrasting colors on the ceiling when the lights are burning to cause the passengers to involuntarily look up at the light and there is no complaint of glare even though the fixture is a foot or more closer to the passenger.

In this series of cars, the battery has been reduced from 300 amp. hr. to the 200 amp. hr. capacity. Lead Planté type are used as well as a number of Edison 225 amp. hr. capacity sets, type A6HW, 25 cells, assembled in 8-three cell trays with a unit tray containing one cell.

It was desirable to keep the weight of these cars down to a minimum and as 200 amp. hr. cells have sufficiently high capacity for coach work in through service they are used in these cars. The battery box remains the same as before in floor area so that 300 amp. hr. batteries may be used if a 200 amp. is not available at any time in the future.

The cells are assembled in rubber jars. Rubber jars have been tested during the last four years and of approximately 2000 jars previously in service, not one has failed. In two instances, cars have been in *fetch-ups* sufficient to knock the coupler off the cars but no damage was done to the jars. The lead lining has proved a failure for the simple reason that grounds are constantly allowing current leaks and the resulting electrolysis eats holes in the tanks. So serious did the trouble become that at one time as many as sixty a week were removed because of leakers. The percentage of leaky linings in those remaining in service has been reduced somewhat through various precautionary measures, but nothing developed that could eliminate the cause of the trouble and the rubber jar offered the best means of preventing grounds—the primary cause of trouble. It has been entirely satisfactory and will replace all lead linings in service as fast as they develop leaks. The initial cost is not so much higher than lead lining with the necessary side and end sheets, porcelain rests, etc., as to be prohibitive, and the freedom from trouble more than offsets the extra cost in a comparatively short time. Battery box floors, hinges eaten up, boxes eaten away cost money and this cost is chargeable to the lead lining as the released acid from leakers is the direct cause of such replacements and repairs.

As previously noted, the generator on the latest equipment is the same as on all previous cars. It has been found advisable to retain this machine with its generous 3 kw. capacity. A generator of 2 kw. capacity could be successfully used and some slight saving in weight and first cost realized. However, consideration of the conditions of service under which these equipments must operate at the present time and the probabilities of the future make it advisable to continue this machine of ample capacity. At the present time a number of cars are lying in various yards as extras ready to protect the service wherever needed. They may make a trip a day or one a week. The trip may be one-half hour or two hours, or a day in length. Extra men often handle these cars and are not apt to be as careful with the light as are the regular crews.

The car may be picked up hurriedly by a train, carried for awhile until the need for it passes, and is then cut off at some yard or siding to lay until needed again. The lights may burn several hours before some one happens along and pulls the switch. The battery is depleted, and the process may be repeated again before the car finally gets on a regular run sufficiently long to charge the battery. No matter how large the battery, it must be charged before it can be used for lighting and the best way to be assured of this is to use a reasonably large generator capable of supplying a heavy current.

Again, many regular trains make but one round trip a day and use light during the entire run. This run may be at high speed or may be covered in slow time but in spurts of speed rather than a low continual speed. Many causes contribute to this, such as congestion, open drawbridges, etc. If one train has trouble during the rush hour it may lose sufficient time to tie up a half-dozen trains behind it. When the way is cleared all trains set out for destination as fast as they can in order to get caught up with the schedule again. The run is covered at an average speed which apparently should take care of the battery but actually the train has been below cutting in speed or far above full load speed a large percentage of the time.

The result is that more current has been drawn from the battery than would appear on the surface and the actual running time has cut down the available time for charging the battery to such an extent that there is a net loss in ampere hours at the end of the run. If a generator puts out full load at 22 m.p.h., any greater speed than this simply cuts down the time available for charging the battery All this is important in suburban service as the longest run is only 1½ hrs. and the shortest, 30 minutes. In each case there are a very large number of stops.

The use of the large generator is a great advantage under such conditions. The current setting may be adjusted to the highest safe output for the machine at the 2-hour rating, making available a quick means of replacing current used from the battery at all times with no injury to generator or battery. It is, of course, imperative, under such conditions, that close attention be given to the matter of the voltage setting of the regulator. It would not do at all to set the voltage maximum so high that no taper charge could take place. With proper voltage regulation, the maximum current setting could be infinite with no danger of serious over-charge. The battery will automatically regulate the current flow to its needs according to its state of charge.

In the case of the 3 kw. generator the current setting is 85 amperes and the battery may partake liberally of this rate or reject all but a few amperes as the need may develop under the conditions of the run. But the point is, that it is available if the speed is high enough and the battery is therefore kept as nearly full as possible at all times.

There are some other points of advantage in retaining the 3 kw. generator which receive consideration. To use a smaller generator, for example 2 kw., would require a considerable investment in spare part stock in addition to the spare parts required to protect the larger machine. It is not advisable to make a change on this account unless other advantages outweigh the disadvantages of maintaining such varied stocks as would be required. As to the future, it is quite possible that these equipments may go out in branch line service either on the older cars, or because of removal from the latest cars owing to the adoption of electric operation. If such a contingency arises the machines may be converted into exceptionally low speed full load machines by simply changing the armatures. This is an important consideration as it is quite sure to come before any of this long-lived steel equipment reaches the end of its usefulness.

The question of putting train lines on all cars was debatable ground during the early days. Electricians are the mose efficient and reliable body of mechanics, of course, and never admit a light failure as among the possibilities. Statistics record cases of cars which were somewhat "dim" and provision must be made to remove the "dimmers." The question of equipping some 8 miles of yard track with charging facilities was not particularly alluring yet it must be done if cars were to be protected against trouble due to low battery. Certain of the outlying suburban yards would need facilities of this kind as well and the cost would run into large figures. Even so, small yards would be as apt to have trouble as the larger ones. It was decided that the train line would remove the necessity for such charging plants and they have been included in the installation on every car with entire satisfaction. With the large capacity generators it was logical to use this capacity in such manner that each car would be equipped to assist a car in trouble by means of the train line which means that the protection was at hand whenever the car in trouble might be put in a train. This is obviously better than depending on charging plants at fixed points. No charging facilities are installed in any suburban yard and none are contemplated. The cost of installing train lines is very low in comparison with the cost of charging plants and the cost of upkeep is also much lower than any charging plant could possibly be. With the improved receptacle equipped with dust cover, very little attention is required and this method has proved entirely adequate as a means of relief when needed.

Much more might be written as to the whys and wherefores of certain features of the various installations. It has been the endeavor to install satisfactory apparatus and continue to use it on all equipment until decidedly superior apparatus is available. The maintenance forces become thoroughly familiar with the equipment and are able to locate and remedy trouble in a short time, as each equipment is practically the same as any other in its operation, repair stocks are kept at a minimum, uniform results may be had and routine inspection periods covering the whole equipment are easier to put in operation as each car will require practically the same treatment. Adequate light is required, but this requirement must be met at a price within reason. There are a number of desirable features in connection with maintenance which it has been impossible to incorporate, but each new feature must be studied before adoption as it is undesirable to have to retrace steps because of hasty adoption. By making haste slowly in this respect it has seldom been necessary to tear down what has been built up and the present service is felt to be very satisfactory both from the standpoint of the passenger who buys the service and the company which furnishes it.

Possessing extensive water power resources, Canada's progress in the consumption of electrical energy has been marked, and today there has been developed 3,227,000 horsepower of the total minimum potential 18,250,000 horsepower of the country's known water power possibilities. The developed water power, 2,411,700 horsepower is in central station plants. While transmission networks do not cover Canada as thoroughly as some districts of America, there are a number of large distribution networks in the better settled area.

Elementary Theory of Alternating Currents

A Series of Practical Articles Explaining a Difficult Subject in a Simple Manner

By K. C. Graham

Part XI. Repulsion Motors and A. C. Measuring Instruments

WE learned in our study of the synchronous motor that it is essentially a constant speed motor and that its speed, between no-load and full-load, varies not a revolution. We also learned that the squirrel cage induction motor might be classed as constant speed because of the fact that its speed rarely varied more than five per cent between no-load and full-load. We also noted that it was possible to obtain a certain degree of speed variation with the wound rotor motor by inserting resistance in series with its secondary winding, but that this speed variation was not stable in that the speed is different for every variation in the load. We particularly noted that the single-phase motors of either type had little starting torque, in fact, the synchronous motor has no starting torque unless we add a small squirrel cage winding to the pole faces. It is possible, by means of the addition of a commutator and brushes, to make the single-phase induction motor exhibit a stronger degree of starting torque than is evidenced by the polyphase induction motor and also to give it the much desired variable speed characteristic. It is possible to construct a polyphase motor along these same lines, but such motors have only recently been developed and may be said to be in the experimental stage; therefore, we shall limit our study to the consideration of the single-phase commutator type motor.

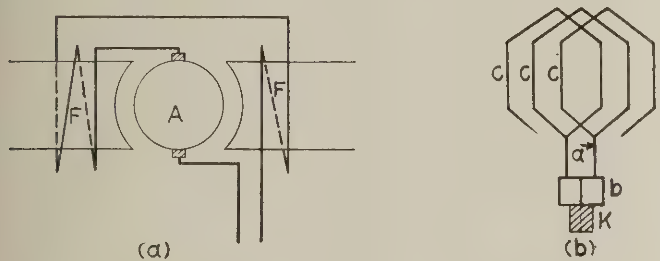


Fig. 112

The first motor of this type was the ordinary series motor, Fig. 112 (a) very similiar to the direct current series motor except for the fact that the field circuit was constructed along the same lines as the stator of the ordinary induction motor in that it was of the laminated and slotted type. This type of motor will operate on alternating current by virtue of the fact that the current through the field and the armature changes at one and the same time so that the same direction of rotation is maintained—it being remembered, of course, that to change the direction of rotation of the ordinary direct current motor it is necessary to reverse either the direction of the current in the armature or in the field circuit, but not in both, because changing the direction of the current in both is equivalent to a double reversal. The trouble experienced with this motor under operating conditions was the fact that it did not commutate well, the brushes sparking at all loads from no-load to full-load and showing a marked tendency to flash over from brushholder to brushholder if the load were suddenly increased. This was caused by the fact that the current induced in the coil undergoing commutation was so great that it in conjunction with the natural flux due to armature reaction reacted on the field flux so as to cause it to shift, thereby moving the neutral point. It might seem that this condition could be remedied by shifting the brushes, but as a matter of fact this procedure served to aggravate the condition and to change the speed, the flux shift increasing as the brushes were moved. The strength of the current induced in the coil short-circuited by the brushes could be reduced, however, if its resistance were increased at the time that it was undergoing commutation. This fact was accomplished by the method shown in Fig. 112 (b). The coils, *c*, of the armature winding are connected together in lap formation back of the commutator, as shown, and a german-silver conductor, *a*, connects each junction (pair of leads) to the commutator bars, *b*. Then when the coil is short-circuited by the brush, *K*, the path of the induced current includes two of these high resistant german-silver conductors and the current in the coil is thereby limited to a smaller value than it would be otherwise. It should be noted that the only time that the high resistant connector carries current is at the instant that the coil to which it is connected is being commutated. Thus at any instant there are only two sets of these conductors carrying current, the remainder of these connectors being inactive. Had the winding been so arranged that all of these connectors were active at all times, the winding would be an inefficient one due to the high resistance loss entailed. But this arrangement did not completely overcome the commutating difficulty because the affect of armature reaction still existed, so it was found necessary to furnish the motor with a compensating winding. This winding is shown in Fig. 113.

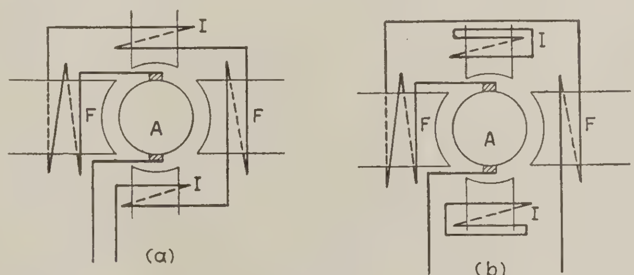


Fig. 113

The two auxiliary or compensating coils, *I*, spaced 90 electrical degrees from the main field poles, *F*, are in the proper position to neutralize the effect of the current in

the short-circuited coil and the armature reactive flux. These coils are connected in series with the armature and main field coils so that the current through them varies with the load and, consequently, their strength varies as does that of the armature reactive flux. By properly designing these coils, as to the number of turns in them, it is possible to completely overcome armature reaction and, at the same time, neutralize the flux due to the short-circuited coil. This form of compensation is called conductive compensation because the compensating coils are excited by means of the current they obtain by conduction rather than by induction as shown in Fig. 113 (b). The coils *I*, Fig. 113 (b) are excited by virtue of current that is induced in them by the armature flux and the effect is like that of a transformer with its secondary winding short-circuited and, therefore, these coils oppose the armature flux as in the case of conductive compensation. But the strength of these coils can never be greater than that of the armature flux or even equal to it, so that neutralization can never be actually or fully accomplished. For this reason conductive compensation is unquestionably the best. This type of motor operates best on a low frequency and is extensively used on 25 cycle railway systems. One type of motor similar to this, but made only in very small sizes, has an armature winding that is entirely composed of a high resistance wire such as

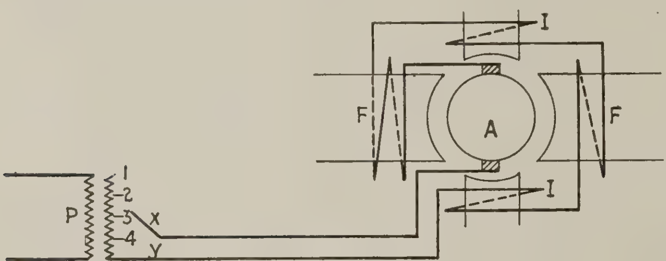


Fig. 114

was used for the connectors in the motor just analyzed. The particular application of this motor is for variable speed work because their speed can be varied by moving the brushes. The current through the short-circuited coil is low, due to the high coil resistance and the reactance of the armature itself is correspondingly lowered so that there is not so great a tendency toward destructive arcing. All this is obtained, of course, at the expense of efficiency, the resistance loss in the armature being very high. It is possible, however, to regulate efficiently the speed of the alternating current series motor by varying the voltage applied to it with the aid of a transformer as in Fig. 114.

A transformer, the primary *P* of which is connected to the line, has a variable secondary winding *S* connected to the terminals of the motor. One of the motor leads is permanently connected to the terminal, *y*, of *S* while the other terminal, *x*, may be applied to any one of the taps 1, 2, 3 or 4. A different voltage is impressed across *xy* for each position of the lead, *x*, thus efficiently regulating the speed of the motor as desired. Except in railway work, the A. C. series motor is little used in practice, the repulsion motor being the more favored type. Before taking up the study of the repulsion type of motor it might be mentioned that the shunt type of motor which would, from a purely theoretical standpoint, seem to operate just as well as the series type of motor is not used because of the fact that the difference in phase between the armature and field currents would be such that little torque would result for a given condition of current in both. Therefore the motor is impractical from an engineering standpoint.

In Fig. 115 (a) is shown a motor similar in general appearance, to the series motor that we are now familiar with. The two main field coils *F* are connected directly to the line and the two brushes of the armature are short-circuited by the jumper *C*. When current flows in *F*, a current will be induced in the armature and the arma-

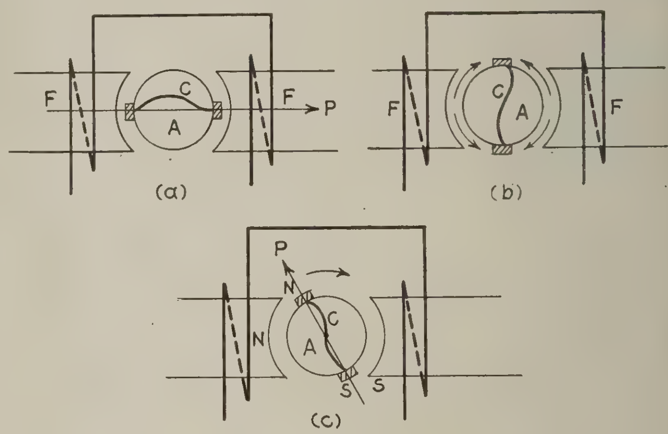


Fig. 115

ture will become an electro-magnet with poles in the plane of the arrow *P*. As shown by the arrows, there is just as much tendency to move in one direction as in the other because of a condition similar to that noted in the case of the single-phase motor. Fig. 115 (b) shows the same motor but with the brushes of the armature in a position 90 electrical degrees removed from that of Fig. 115 (a). In this case no current will flow in the connector *C*, because the voltage is the same at each end of it and there must be a difference of potential to induce

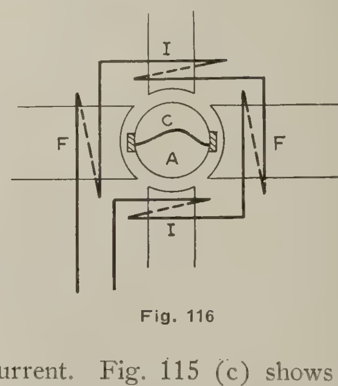


Fig. 116

the flow of current. Fig. 115 (c) shows the brushes at a position intermediate between the two extreme positions. Here conditions are favorable toward rotation because there will be a repulsion between like poles. These poles will remain in the same relative position as long as current is applied to the motor, but the conductors carrying the currrent to form the armature poles will be forced to move because of the action between the flux of the field and that of the armature conductor in exactly the same way as in the case of the direct current motor. What actually happens is that the motor runs by virtue of

strict motor action while the poles of the armature are in such a position that there is repulsion between them and the field poles rather than attraction. Thus in Fig. 115 (c), with the motor operating in the direction indicated by the arrow, due to the motor action between the flux due to the current in the armature and the flux of the field, the armature pole nearest the *N* field pole is an *N* pole while that nearest the *S* field pole is an *S* pole so that there is repulsion between them. Besides eliminating the attraction between unlike poles that would be present in such an arrangement as Fig. 115 (a), this latter arrangement has the effect of giving the motor a positive direction of rotation the instant the current is

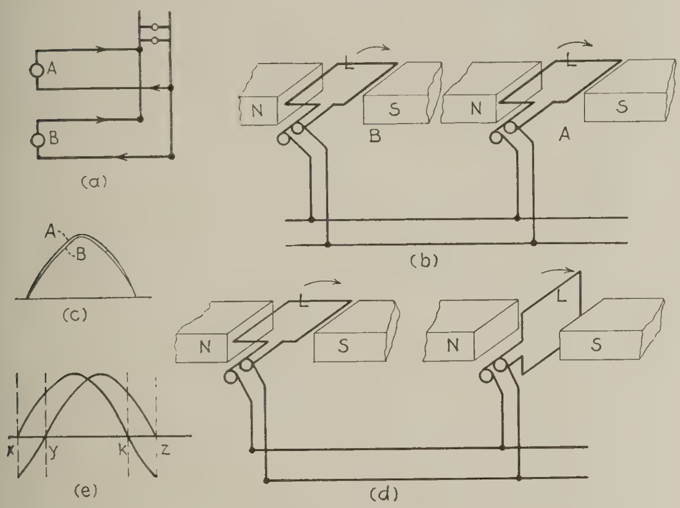


Fig. 117

applied to the terminals because these poles will repel the instant current starts to flow in the armature, while in the arrangement of Fig. 115 (a) the tendency to turn would not be any greater in one direction than in the other.

In order to reverse the motor of Fig. 115 it is necessary to move the brushes 90 electrical degrees from the position of Fig. 115 (c) but this may be accomplished in another manner as shown in Fig. 116. Here an auxiliary winding, *I*, similar to the compensating winding of the series motor, is placed in a position 90 degrees removed from the main field winding and the position of the brushes is permanently located midway between the auxiliary poles. The direction of rotation of this motor may be changed by reversing the polarity of this auxiliary winding. The winding, *I*, induces the current in the armature and the motor action between the conductors under each main pole and the flux of the field pole itself causes continuous rotation of the armature so long as the motor is connected to the line. At starting the motor action between the auxiliary poles and the armature conductors tend to give the armature a positive direction of rotation; if their polarity be changed the tendency will then be for rotation to start in the opposite direction so that the result obtained is the same as that of shifting the brushes on the motor of Fig. 115. There are many types and makes of repulsion motors, some of which have the auxiliary winding so designed and connected that it serves to counteract the self-induction of the primary winding and the motor operates at a high power-factor. The main principle of all of them is essentially the same as brought out in connection with the particular motor we have analyzed. One type of motor that enjoys considerable prominence is the repulsion-starting induction motor. This motor is made in both single and polyphase types and some of the sizes of the polyphase motor are quite large although the single-phase ones are rarely seen in any size greater than seven and one-half horsepower. This motor is equipped with a wound rotor, the winding being connected to a commutator upon which bears a set of brushes per pair of poles. Each set of brushes is short-circuited or connected together by a jumper as in the ordinary repulsion motor. The motor starts as a repulsion motor and operates as such for the short space of time necessary to reach about 85 per cent of normal speed. At this point a centrifugal device acts in such a manner that the bars of the commutator are short-circuited together and the motor operates as a squirrel cage induction motor. The polyphase motors of this type, however, usually have a squirrel cage winding in addition to the commutated winding. Both the single-phase and the polyphase motors exhibit a very large starting torque so that this type of motor is well suited to loads that are very hard to start. Another single-phase motor that has recently come into much favor is one having a double rotor winding similar to the above but with the centrifugal device omitted. This particular type of motor, however, is made in only the smaller sizes.

Synchronizing Alternating Current Generators

Before taking up the subject of measuring instruments it will be necessary to explain what is meant by the synchronizing of two alternating current generators.

Fig. 117 (a) shows two alternating current generators connected in parallel. As in the case of paralleling direct current generators the voltages of the two must be equal before they are connected together. In the case of direct current machines this is all that need be done before throwing in the switch that connects one to the other, but in the case of alternating current machines it is also necessary that the two of them be in phase. Fig. 117 (b) shows the position of the two sets of armature conductors relative to each other. It will be noted that the positions of the loops *L*, which represent the armature conductors, are in the same relative position as regards the field poles of the machines. The two waves of voltage, then, are in phase so that the voltage builds up in the one machine in the same manner and at the same time as in the other machine so that there is no tendency for current to flow between the two of them or, in other words, there will be no local current circulating through the windings of the two machines. When such is the case they are said to be in phase and may be connected together, in parallel, with perfect safety. But suppose that the relative positions of the conductors on the two armatures are as shown in Fig. 117 (d). They will then be out of phase with each other and the voltage waves will be as shown

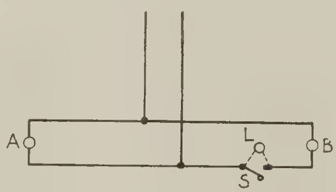


Fig. 118

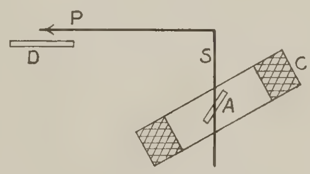


Fig. 119

in Fig. 117 (e) and during the portion of the cycle represented by the distances *xy* and *kz* the two waves will be in such relation to each other that the voltages of the two machines will add up in forcing a local current through the two windings; at other portions of the cycle also there will be more or less voltage difference and current will have a tendency to flow between the machines. Therefore it would be unwise to try to operate them in this manner and they must be synchronized before they are connected together.

Fig. 118 will serve to show how this synchronizing is brought about. Suppose that alternator *A* is operating and that it is desired to connect *B* in parallel with it. *B* is first brought up to speed by means of the engine that drives it; switch *S* has a lamp *L* connected across it; now

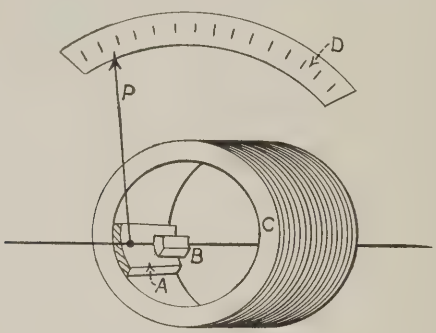


Fig. 120

when the two machines are out of phase the lamp will light for reasons explained above but when they are in phase the lamp will not burn. Now as the speed of *B* is varied slightly the two machines will regularly swing into phase and out of phase again. The operator watches for one of the instants when the lamp is dark and then suddenly closes switch *S* paralleling the two machines. Once they are in phase they do not tend to drop out of phase again because if the prime mover (engine that drives) of one machine slows down temporarily the other machine will drive it as a synchronous motor until its prime mover gets back in step again. Alternators may

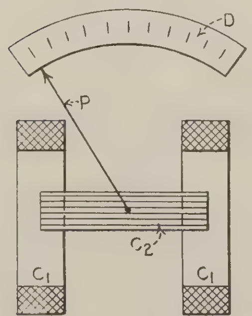


Fig. 121

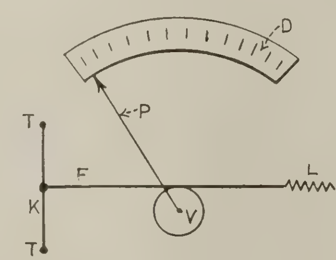


Fig. 122

also be synchronized with the aid of a synchroscope, an instrument that we shall study in connection with measuring instruments.

Alternating Current Measuring Instruments

Many of the same types of instruments used in direct current work are applicable to the alternating current field, in fact any of those instruments that do not include a permanent magnet in their makeup may be used equally as well on one as on the other. There are, however, some types of alternating current instruments that can not be used on direct current.

Alternating current instruments are made in a variety of types; induction, inclined coil, shaded pole, repulsion, hot wire, electrodynamometer, vibrating reed and combinations of these. We shall first consider some of the types of voltmeters and ammeters.

Fig. 119 shows an inclined coil voltmeter or ammeter,

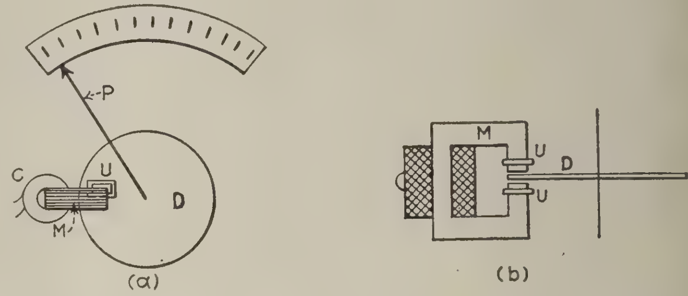


Fig. 123

depending on the winding of coil *C* as to which it is—a fine winding of many turns being used in case of voltage measurements and a heavy winding of few turns if the instrument is to be used for current measuring. This coil is set at an angle to the vertical. Attached to the shaft *S*, which pointer *P* is fastened to, is a soft-iron piece *A* set at a different angle than is the coil. Now when current flows through the coil a magnetic field is established through the center of the coil and piece *A* tends to turn so that it is parallel to these lines. The farther it turns the more nearly it gets to this parallel position. The turning tendency of the shaft is resisted by a spring so that the greater the current, and con-

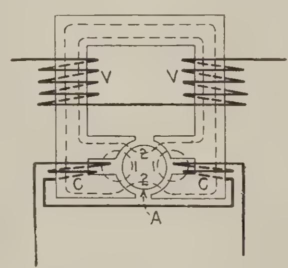


Fig. 124

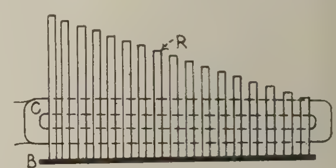


Fig. 125

sequently the greater the magnetism of coil *C*, the greater distance the shaft will move so that the degree that the pointer is deflected will depend on the current through the coil. Therefore the dial *D* may be marked off in volts or amperes as the case may be, and the pointer will indicate the voltage or the strength of the current by the position that it indicates on the dial.

Fig. 120 shows a repulsion type of ammeter or voltmeter. The principle upon which this instrument operates is that of repulsion between like poles. The piece of iron *A* is fastened to the inside of coil *C* while piece *B*, of the same material, is fastened to shaft *S*. When current flows in *C* the two pieces *A* and *B* are magnetized in the same direction and their like poles will repel, thereby causing *S* to move against the action of a spring and *P* to indicate as in the other type of instrument just analyzed.

Fig. 121 shows an electrodynamometer instrument.

There is no iron in this type of instrument, hence its name. The coils C^1 and C^2 are connected in series and a shaft passes through coil C^2. The magnetic action between the two sets of coils causes the pointer to move over the dial. This type of instrument is not so well suited to use as an ammeter because the heavy leads necessary to carry the current to coil C^2 would make the instrument impractical so far as accurate results are concerned.

Fig. 122 shows a hot-wire type of instrument. *K*, which is connected between the terminals *T—T* is a wire made of material that expands considerably with slight increases in current. This wire is drawn taut between *T* and *T* and has a fine thread *F* fastened to it. This thread is wrapped around pulley *V* and another thread

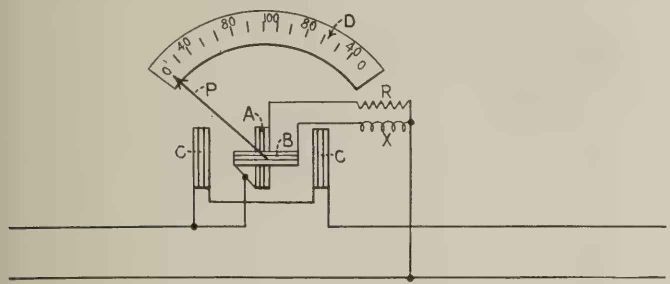


Fig. 126

which is attached to spring *L* is wrapped around the pulley in the opposite direction. Now when current flows along *K* it causes *K* to expand; spring *L* exerts a tension causing the pulley to rotate until it is stopped by the tension of *F*; if the current increases further the pulley rotates a little more moving the pointer along the dial to show this increase of current; if the current decreases *K* contracts and the tension of *F* causes the pulley to revolve in the opposite direction so that *P* shows the decrease in the current.

Fig. 123 (a) illustrates a shaded pole instrument. Coil *C* furnishes the excitation for the magnetic circuit *M* between the poles of which passes one side of an aluminum disk *D* as shown in Fig. 123 (b). Set in the faces of the poles of *M* are shading coils *U* similar to the shading coils used in one of the single-phase motors that we studied. When current flows in *C* a revolving or shifting flux that reacts on the currents induced in the disk *D* thereby causing rotation of the disk in the same manner that the rotor of the induction motor is caused to revolve. This tendency to rotate is, of course, opposed by a spring as in other types of instruments.

Fig. 124 shows a single phase induction type of wattmeter. The two coils *V* which consist of many turns and are, therefore, highly inductive, are connected across the line and are affected by the voltage of the circuit while coils *C* are connected in series with the line so that they are affected by the current in the circuit. Since *V—V* are highly inductive the current through them and, consequently, the flux caused by them, will be 90 degress out of phase with the flux engendered by coils *C*. The action of these two fluxes will be such as to cause a form of rotating field as indicated. The paths *1—1* show the flux due to the current coils *C while 2—2* show the flux due to *V—V*. This rotating flux imparts a rotating or turning effort to rotor *A* thereby causing the pointer to indicate as in any of the other types of instruments. For measuring polyphase currents two or more of these elements may be connected to the same shaft so that the turning effort of the system shall be governed by the sum of the power in the two or more phases at the instant.

Fig. 125 shows a vibrating reed frequency meter for testing the frequency of a circuit. *R* are iron strips of various lengths fastened to a wood strip *B* at one end and free to vibrate at the other. It is known that every piece of metal has a natural period of vibration depending on its length, thickness and the material of which it is composed. If a piece two inches long is bent backward and then let go it will always vibrate at the rate of a certain number of vibrations per second, for a time, until it loses a large part of the energy that was imparted to it by bending it back. Again, it has been found that if a number of these strips are brought near a violin and notes are struck on the violin, different strips will tend to vibrate for each of the different notes struck. In other words they are set in motion when a note is struck that has the same rate of vibration as the natural period of vibration of the strip. This principle is made use of in this frequency meter. Coil *C*, placed behind the strips, is excited by the circuit of which we wish to know the frequency; when the current is passed through *C* the magnetism through the core of *C* will oscillate at a certain number of cycles per second; if there is a strip which has a natural frequency corresponding to this frequency it will vibrate. The strips are accurately tested and marked so that the frequency may be read directly.

Fig. 126 shows a type of power factor indicator. Coils *C* are connected in series with the load, as are the current coils of wattmeters; coils *A* and *B* are connected together and to one side of the line at one end; the other end

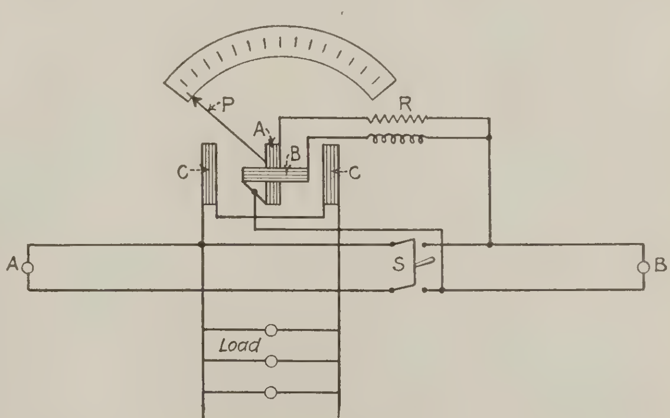


Fig. 127

of coil *A* is connected to the other side of the line in series with resistance *R* while coil *B* makes connection to the line through inductance *X*. The dial is marked from zero to one hundred at the center and from one hundred down to zero at the other side, one side indicating lagging power factors and the other leading power factors. The current through *B* is 90 degrees from that in *A*, the current in *A* being in phase with the voltage—this follows of course from the fact that the circuit of *B* is highly reactive while that of *A* is highly resistive. Now if the current is in phase with the voltage the current in *C* will be in phase with the current in *A* and there will be an interaction between the fluxes of these coils causing the pointer to take a position showing 100 per cent power

factor, the effect of the current through B being negligible because of the fact that the current through B would be most active when that through C is zero. If the load is totally reactive the current in B will be in phase with that through C and the effect of A will be negligible, and the moving element will turn so that the plane of B is parallel to the planes of coils C, thereby indicating zero power factor. For other conditions of load the moving element will take up some intermediate position depending on the degree that each of the two coils A and B are active; this depending of course on the amount that the current leads or lags behind the voltage.

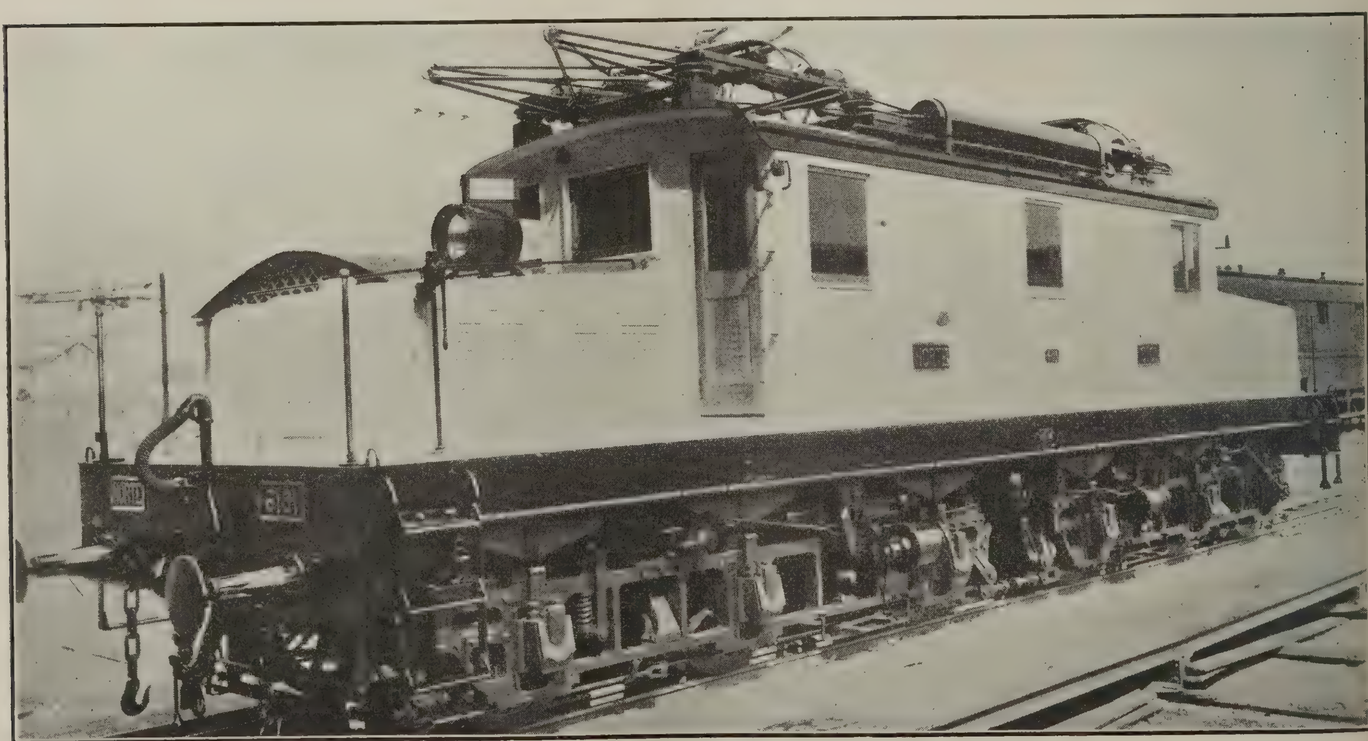
In Fig. 127 we see an instrument exactly like that of Fig. 126 except for the fact that the terminals of the moving element are not connected across the circuit to which the coils C are connected. As used here the instrument is used to indicate synchronism prior to paralleling two machines. The coils C are wound so that they may be connected in shunt across the line as shown but winding them in this manner makes them highly inductive. The terminals of C are connected to the terminals of the machine that is already in operation while those of the moving element are connected to the terminals of the machine that is to be connected in parallel with the other one. If the two machines are in phase or synchronism B will be active and the pointer will register the in-phase condition. If they are 90 degrees out of phase coil A will be active and the pointer will indicate the condition. As in the case of frequency measurements, intermediate conditions will be indicated by intermediate positions of the ponter relative to the dial markings. If the incoming machine is running too slow so that its frequency does not correspond to that of the other machine the instrument will indicate this by the fact that the pointer will appear to revolve backward—that is, it will move up on the dial and then gradually slip backward, then suddenly catch up again and then slip backward; or if the incoming machine is too fast the pointer will creep ahead and then suddenly fall back several times a minute. Thus the operator can tell whether to speed up the machine or slow it down and the pointer will positively indicate the synchronous condition when it has been reached, thus eleminating any guesswork on the part of the operator.

Changes in Electrical Safety Code

Inclusion of rules for the construction of radio antennas, prohibition of grounded returns on power circuits in cities, and changes in the loading map so as to permit lighter line construction to Montana and the greater part of Wyoming are among the changes to be embodied in the next edition of the National Electrical Safety Code. These changes were finally approved at a meeting of the Sectional Committee dealing with the code which was held at the Bureau of Standards March 5 and 6, 1925.

According to the procedure of the American Engineering Standards Committee under whose jurisdiction this code comes, the code must be revised at intervals of a few years so as to keep its provisions in accordance with the most modern practice.

The decision to change the loading requirements in Montana and Wyoming is due to evidence that these states are not as subject to ice as had been formerly supposed. They have been changed from heavy loading territory to medium. Wires in heavy loading territory are required to stand a thickness of half an inch of ice, with a wind pressure of eight pounds per square foot of projected area of the ice coated wire. In medium territory only a quarter of an inch of ice is specified.



Westinghouse-Baldwin-Naval Locomotive for The Northern Railway of Spain

Electrical Construction at Transcona Shops

Power Distribution and Steel Supporting Towers Are Outstanding Feature of Big Plant

By Alfred C. Turtle
Shop Electrical Engineer, Canadian Government Rys.

CONSTRUCTION, in the electrical sense, covers such a wide variety of types, that to deal satisfactorily with any one phase of it involves a considerable amount of forethought and planning if the subject is to be properly covered. Especially is this true if the construction is to be of such a standard as to fulfill all the requirements that are demanded by the N. E. Code, Safety Standards, common sense, and economic considerations. This last is, of course, the governing feature, in as much as it governs the first cost of the installation, the lasting or life qualities, and indirectly the depreciation rate on the first cost, which must unfortunately be written off against all of man's handiworks.

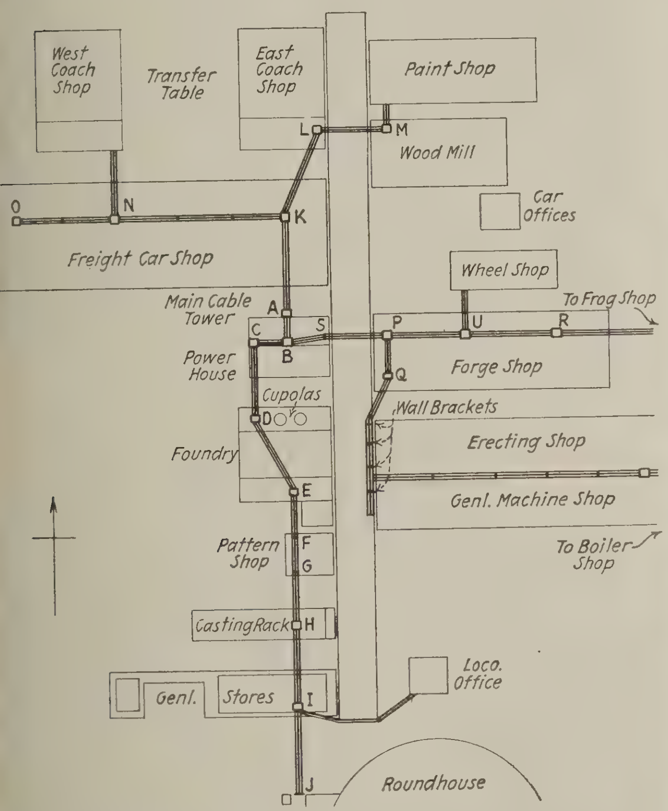


Fig. 1—Plan of Shop Buildings Showing Arrangement of Feeder Lines and Location of Towers

It also governs the permanency of such work, to the extent that when laying out, one's imagination must be well stretched in order to anticipate possible future additions of load, possible changes of machinery location and changes in buildings.

Limiting factors from the economic standpoint are very active in controlling the amount to be expended, and thereby the style of construction. For instance, the railway may value the increase of efficiency in changing its illumination from an already existing gas installation to an electrical one, as of very small difference. Similarly in changing from steam to electric drive, where the cost of available sources do not leave room for much of a saving in the adoption of the superior power, may not be looked upon enthusiastically.

It then becomes a very trying problem to ensure that the installation will be all that the local conditions require, that it will fulfill a reasonable life and that estimated cost and its attendant savings, either in actual maintenance or increased efficiency and output, will be such that the "powers that be" will feel fully justified in approving the expenditures.

One often hears unjustified criticism of installations made by those not conversant with the limitations that bounded that particular case, in which references are made as to its cheapness (disparagingly) or vice versa, its elaborateness or its unnecessary features, etc.

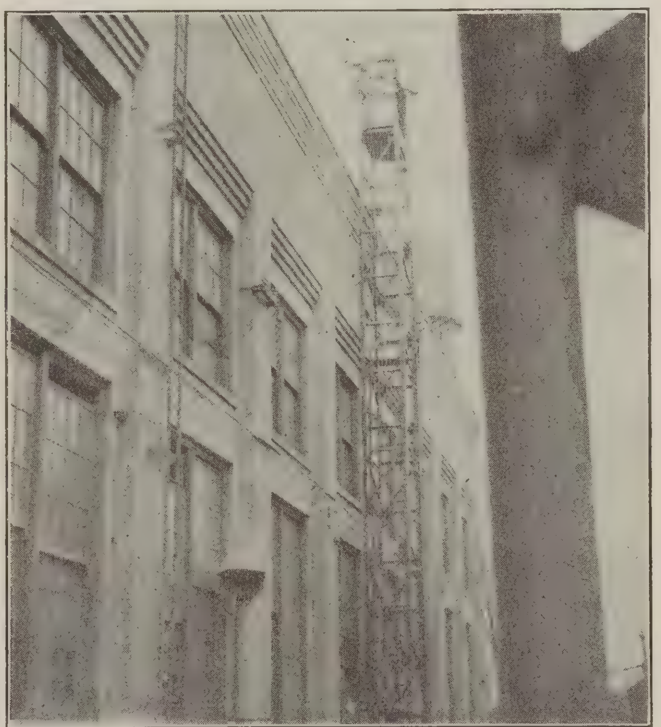


Fig. 2—Showing Steel Wire Tower Located in Rear of Switchboard in Power House. This Tower Will Carry 85 Cables to the Roof.

However, one must "grunt and sweat under a weary load," as Hamlet hath it, and bear these ill-considered comments with good-will and patience, having in mind that good service and conscientious work will eventually come out on top in the majority of cases.

In general, railway electrical apparatus must then follow reasonable standards, so that maximum interchange will rule. By that is meant, that for divisional point apparatus, a standard voltage must be used for power, and

also for light requirements. This is followed, of course, by most electrical departments, in that voltages of 6,600-2,200-440-220 and 110 volts are generally found in the United States. A similar scale exists in Canada, except that 500 volts is in general favor for a. c. power instead of 440 volts. As these are standards which have been adopted originally we cannot lay claim to their establishment, but only to the use of them. We can, however, lay claim to the standardization of our generating unit systems, car lighting and headlighting systems, yard lighting, charging systems and electrification generally applicable to railroading.

It follows then that in laying out systems at divisional points the electrical engineer in charge should in all cases be guided by the principle of standardization, in that his generating units can be used at any of those stations, and that he uses sizes reasonably efficient in their several applications. By this is meant that a certain type can be decided upon, whether it be a single non-condensing, or

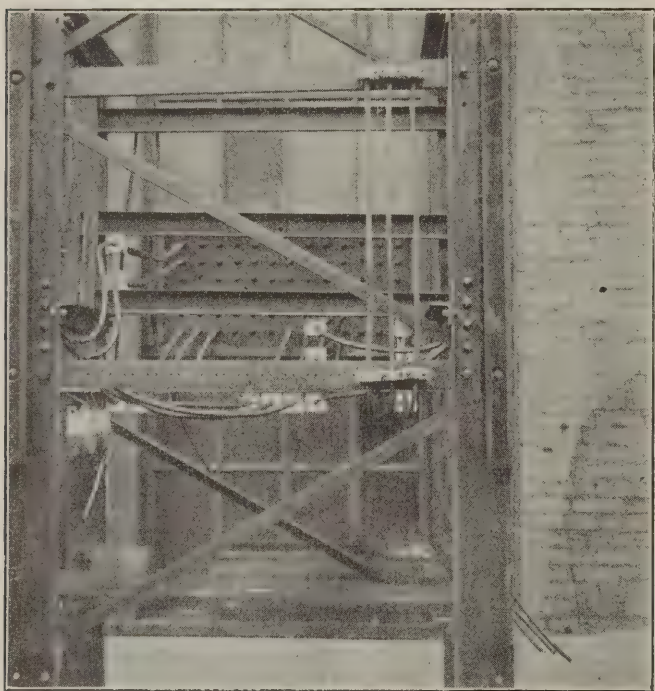


Fig. 3—Showing How Feeders Come Through Wall of Power House and Arrangement on Tower

compound steam-driven unit, or the steam turbine unit, and that the relative sizes of such units will cover the requirements of each divisional point for at least a future period of five years of normal growth.

As a general overhaul can be considered essential after such a period, it is quite reasonable to figure that a larger machine may replace the machine being overhauled.

If this practice be comprehensively understood it will follow that when a new station is opened up in the normal growth of a railroad, its power or lighting generating equipment will be of the smallest type that has been standardized on, say, a 10 kw. single non-condensing engine-driven type. The large divisional points, feeding main and branch lines, will be equipped with the largest units, such as 500 kw. type turbo-generator. This arrangement will have its exceptions, but can be followed generally.

If such a system is followed, it will be simple matter to re-arrange these units, and place them satisfactorily to handle the ever increasing load conditions that develop with the advance of the railway.

This interchange of generating equipment, if followed carefully, means that each new station opened up will

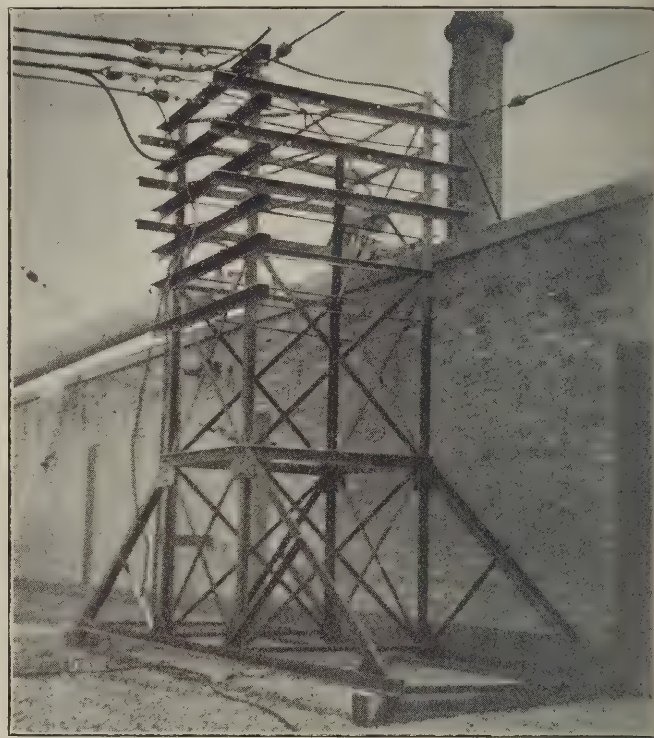


Fig. 4—Showing "B" Tower As Indicated in Plan, Fig. 1

have the small type plant, taken from other stations, applied to its use. The bigger and older stations will benefit indirectly by having the larger and more economical units

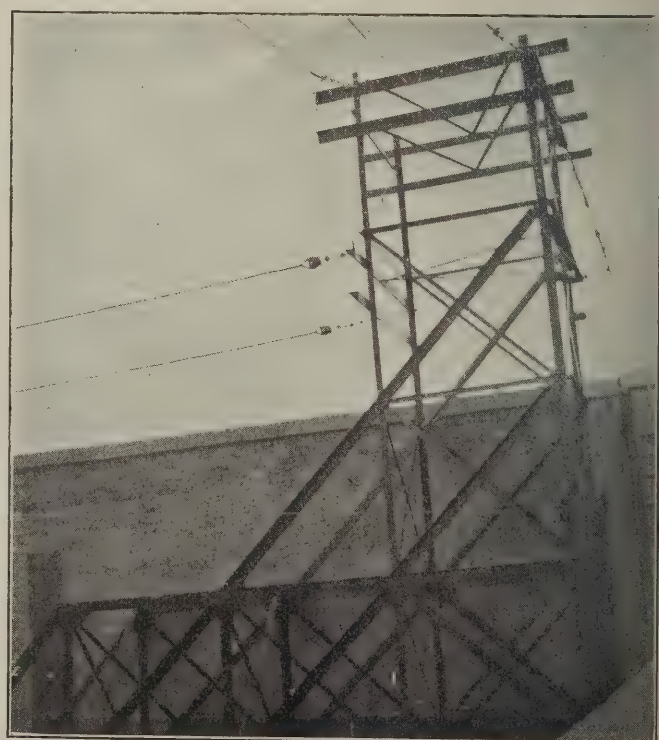


Fig. 5—View of "C" Tower Before Cables Were Applied. This Tower Takes Tension of Cables Directly Into Its Own Structure One Way and Uses Guy Cables to Take Care of Quarterway Stresses

applied to them. In some cases the demand for power and the available outside sources may mean an inquiry into the local costs of such source. A close examination of rates will very quickly establish the point of economy; that is, whether it is cheaper to generate your own power or to purchase power.

It can be assumed, in general, that at a divisional point

Fig. 6—"F," "G," and "H" Towers. Showing Lowered Cable Towers Feeding Lower Roof Buildings Such as Store Houses, Offices and Roundhouse. Pattern Shop in Foreground

of, say, 18-stall size, equipped with 500 boiler hp. complete with washout plant, shop machinery, air compressor equipment of 1,000 cubic feet per minute capacity, purchasing coal at a price not exceeding $7.00 per ton, can safely be equipped with a 100 kw. compound non-condensing engine driven unit, that will handle all auxiliaries,

Fig. 7—Tower "E," a 26-Ft. Tower on Roof of Foundry

such as coal chute, shop machinery, pumping equipment, yard and shop lighting, except air compressor, which should, of course, be a direct steam-driven unit.

It can also be assumed that the cost of taking care of such requirements, after making proper proportion of cost of fuel, fixed charges, labor, overhead, waste oil and repairs, will not exceed .02c per kw. hour for such a plant runs at least 55,000 kw. hours per month.

A divisional point located at, or in a large town, should consequently be close to a reliable source of supply, and if in a final analysis power will actually cost around .02c per kw. hour or less, it may be advisable to purchase power. Local conditons should settle this point, and if the local plant was free of breakdown under ordinary conditions, it may be good policy to support it as far as can be done.

In laying out engine rooms at divisional stations, the policy of laying reinforced concrete mats the full size of the building instead of individual foundations for each unit is generally more suitable. Foundation bolts can be sunk in at any location, and only grouting or concrete filling is necessary for the installation of different units. In fact, such an arrangement would be superior in every

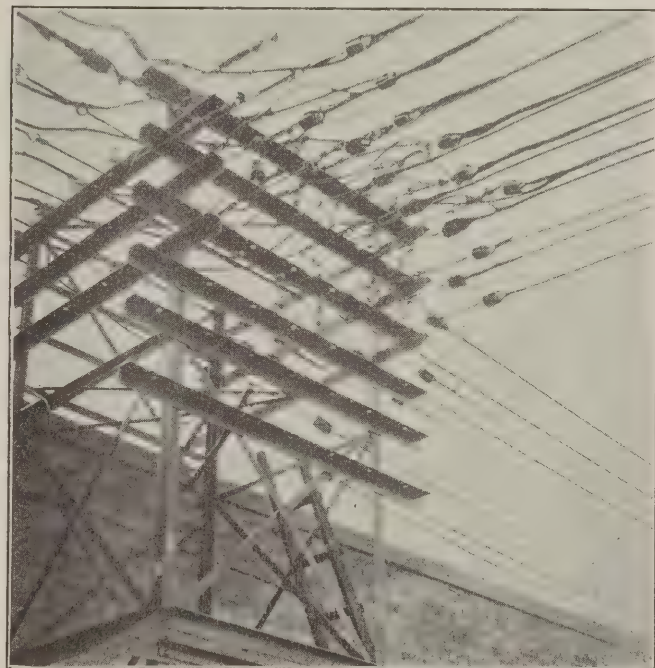


Fig. 8—Showing "C" Tower with Partly Completed Cable System Applied

way for machine shops, as well, instead of the present scheme often used of putting in deep and expensive masses of concrete for each individual machine. Very often such machines are shortly moved to a new location on account of displacement by a superior machine, etc.

There are exceptions to the rule, of course, where the character of the unit, due to its size, auxiliary apparatus or amount of space available, will require a specific foundation of concrete. When no compromise can be made the special foundation will have to be built, but for average apparatus it can be safely assumed that a reinforced mat will take care of all requirements.

One important question, which has often been debated, is whether the design should be handled strictly on the job, or whether it is better to do the design work at headquarters. It would seem that as the estimates, standards of construction and general program of construction are absolutely a headquarters affair, it would naturally follow that all drawings should be submitted to that point for a review of the layout and estimate of cost. It is equally certain that rough drafts of the wiring and power design

are necessary in order to make proper estimate on cost. Therefore, to avoid duplication of work it should follow that all of the design and instructions should emanate from that same office.

In the actual erection or installation it is, of course, necessary to have an engineer or foreman in charge who can be depended upon to adjust the original plans to any changes or unforeseen obstacles that arise, and whose duty would be to record properly such changes in the field and notify headquarters of these changes.

If the rough drafts are sent out prior to the actual estimates to this same person, many future changes can be prevented and, therefore, a truer estimate be made in actual cost. Local conditions will then be taken care of so that feeders will come in at the proper place assigned for them. What is more important, a proper and true record would be shown on blue prints of such work at all times, so that as each addition is made there will be no tendency to overload feeders or exceed reasonable voltage drop in the lines feeding the different sections or buildings.

Fig. 9—Showing Complete Bridge of Tower "D" on North Section of Foundry

If some check or control over such layouts is not exercised, very haphazard and conflicting types or designs will result. Illumination of various classes of work will vary unsuitably and unscientifically, store's stocks of renewable fittings will increase beyond reason, and breakdowns will become serious, in that special parts will have to be obtained in each case.

In other words, standardization is absolutely essential, but should be such that compromise can rule to keep pace with advancing science and improved methods.

Feeder Construction

Feeder construction for railroad work may come under three headings—pole lines, tower lines and underground lines.

Wood pole lines are generally used at and around divisional points, yards, wharfs, along the right-of-way feeding isolated buildings, etc.

Tower lines of either steel or wood are used over buildings and for special transmission work and underground feeder construction.

Messrs. Coombes, Lindquist and Steel have treated the subject of pole and tower lines in concrete, steel and wood so excellently that it would serve little purpose to review such work as this, and similarly Meyer has treated underground work. The handling of heavy cable work between large shop buildings doing heavy repair work, how-

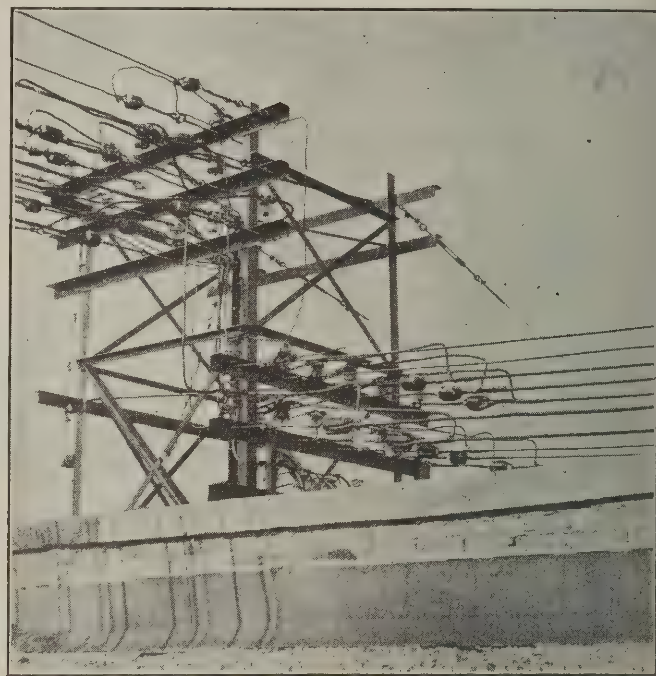


Fig. 10—Another View Showing Partly Completed Cable Work on Corner Tower "C"

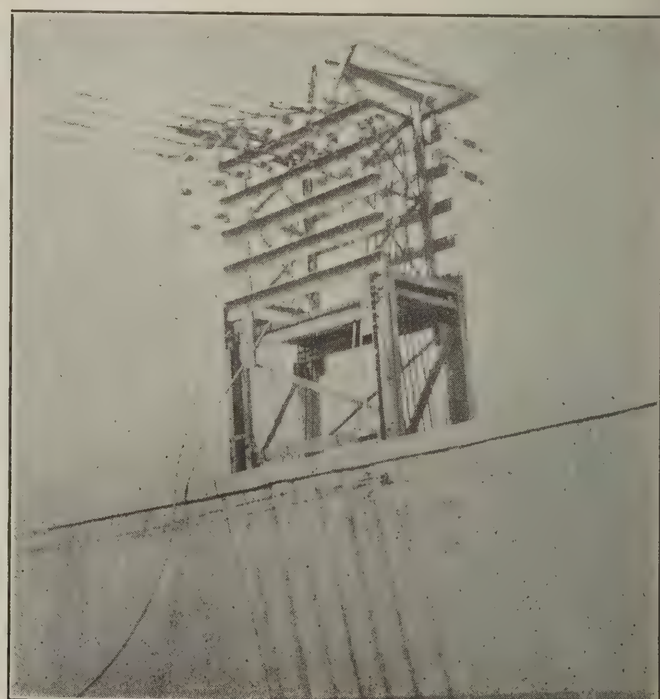


Fig. 11—Showing Partly Completed Cabling Running South on Riser Tower "A"

ever, is a subject which these gentlemen have not touched upon, so that the following material may be of value showing the type of construction used at Transcona shops of the Canadian National Railways.

Fig. 1 shows general layouts of buildings and arrangement of feeders handling lighting and power requirements.

Fig. 2 shows the main wire tower taking cables from the rear of switchboard up to the level of the roof cable system. This is designed to take care of eighty-five cables which will be arranged on all sides of the tower, and also half the rectangular space inside, leaving ample room for men to go up it inside to take care of any repairs which may be required from time to time. The cables come from each feeder switch in rack formation through two separate one-inch thick transite boards spaced four inches apart, as shown in Fig. 3. Strips of lumber at each corner of this structure are shown here which will later have horizontal two by four pieces nailed to them, after which corrugated iron sheeting will cover the whole against moisture, etc.

Fig. 4 shows lead off tower for all feeders handling loads south of the power house, running east and west. Note the method of transferring load to main building girders by means of Howe trusses.

Fig. 5 shows a tower designed to take care of end pull one way, without transferring the load through guy wires to other structures. These towers are approximately sixty-five feet above ground level, and in this case guys could not be used, due to lack of anchorage. Cables running quarter to this direction can be guyed as shown.

Figs. 6 and 7 show application of high tower to suit height of cables in line with other buildings, and type of flexible tower for short span on pattern shop roof.

The use of bridge trusses to support tower structures is possibly a departure from usual practice, but it is an extremely simple and reliable method of handling such a problem. Buildings are generally built in sections of steel work, whose bay widths vary from 16 ft. to 20 ft. The 4-ft. square tower seems to be ideally suited for the division of the cable stresses, and fits the dimension of one 4-ft. panel in a 20-ft. or 16-ft. bay truss, so that it becomes a simple matter to design a truss suitable for this work in each case.

All members are double bolted, and the cross-arms are of heavy 4 in. x 5 in. x 5/16 in. angles, braced in the centre to the opposing legs of tower, as will be clearly noted on Fig. 5.

Figs. 8 to 11 show cabling partly completed on these towers.

The Selection of Brushes*

This important problem, the selection of proper brushes for a given service, is a difficult one to handle, and much enlightenment cannot be given in the space allotted in this article. The reason for this can easily be seen if we stop and consider for a moment the large number of different makes and types of motors and generators using brushes that are now on the market. It is not within the scope of this article to cover anything but stationary equipment, although it is very hard to draw a definite line between the fields of stationary and traction equipment.

*From a bulletin published by the National Carbon Co.

Ordinarily, when we speak of traction equipment, we think of electric railway motors and the like, but today, with the increasing use of industrial trucks, electric vehicles, starting and lighting equipment on gas cars, crane motors, mill motors and other heavy duty equipment, we find that the engineers, electricians and operating men in both central stations and manufacturing plants must not only be familiar with stationary machinery, but must also become acquainted to a certain extent with traction apparatus. Even the so-called household and office appliances, such as vacuum cleaners, adding machines, dictaphones, etc., all equipped with motors and all calling for brush renewals, have invaded both the central station and manufacturing plants. These small appliances also demand the attention of the engineers and operating men in charge.

The selection of a brush for a definite service is largely a matter of experience. The phenomena of commutation are excessively complicated when you consider all the variables that can enter into the operation of a brush in the shape of quality and condition of the commutator and brush, the thickness, pressure, distribution, wear, etc. The selection of the proper brush is dependent on the judgment and ability of the person selecting the brush in balancing these variable characteristics to eliminate one source of trouble, and perhaps strengthen other desirable characteristics. This applies to the machine designer, the machine manufacturer, the electrical engineer and the operator. Each of these comes into contact with carbon brushes in a different way. The machine designer and manufacturer build a machine and specify conditions under which it should be operated. The engineer and operator install the machine to meet their requirements. It may be that the engineer gets a machine of proper capacity, speed and voltage, but it is the operator who has the problem of fitting the machine to particular conditions.

It has been found that many irregularities of operation are manifested at the brushes in the form of heating, sparking, pitting of the brushes, etc., and also that it is necessary to have proper brushes to enable the operator to get maximum efficiency for the machine. Unless the operator has had much experience in the selection of brushes, he is very liable to get into difficulty. In our opinion the brush manufacturer, with his staff of brush engineers, is the logical man to prescribe brushes. The National Carbon Company, Inc., manufacturer of carbon products for over a quarter of a century, has a staff of brush engineers who have been solving brush problems for all of the electrical industries, and have gathered data which enables them to specify the proper grade of brush for all makes and types of machines. The engineer is able to specify the proper brush from a data sheet which the customer fills out, giving all the necessary information.

It might be well to enumerate and classify the electrical and mechanical characteristics of brushes as studied and applied by the brush engineers. To experiment with different grades of brushes is dangerous business, and, if done at all, should be done with extreme care. We are giving the following characteristics with the idea that they are to be used to assist in the selection of brushes.

Electrical Characteristics

1. Specific resistance.
2. Contact resistance.

3. Variation in specific resistance and contact resistance due to heating.
4. Carrying capacity.

Mechanical Characteristics

1. Size—length, width and thickness, including special shapes.
2. Connection of shunts or pigtails.
3. Coefficient of friction.
4. Hardness.
5. Strength.
6. Abrasiveness.
7. Density.
8. Thermal conductivity.

Brush Composition

Both the electrical and mechanical characteristics of brushes vary with the composition. Brushes may be classified according to their composition as follows:

1. Pure carbon brushes.
2. Carbon and graphite brushes.
   (a) Mixtures of carbon and artificial graphite.
   (b) Mixtures of carbon and natural graphite.
3. Electro-graphitic brushes, in which the graphite properties are brought about by a special electrical treatment.
4. Pure natural or artificial graphite brushes.
5. Brushes impregnated with a lubricating material.
6. Metal-graphite composition brushes.
7. Compound brushes which are composed of alternate layers of carbon and metal.

Armatures Should Be Dipped and Baked

By James T. Hamilton

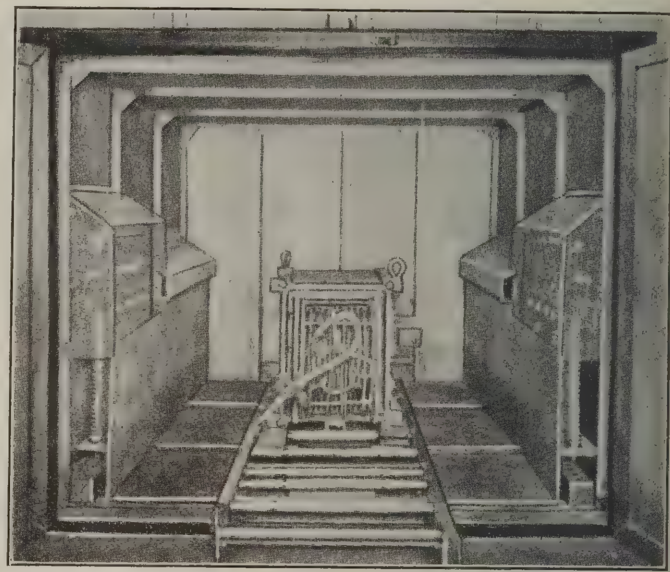
Master Mechanic, New York, Westchester & Boston Rwy. Co.

One of the most important problems confronting electrical operation of railways, especially the high speed lines where light weight is essential, is caused by the gradual deteriorating of the insulation of motors and transformers. The dust, dirt and metallic particles on road bed combined with moisture, tend to break down motor insulation and put the car out of service. The consequent interference to regular operation results in losses to the line that frequently assume serious proportions.

To increase the life of their motors and transformers, the New York, Westchester and Boston Railway have proved to their own satisfaction that it is essential to coat properly the armature and coils with an insulating varnish and to bake out this coating thoroughly. A complete dipping and baking equipment has been installed, including a varnish dip tank and an electrically heated and automatically controlled Westinghouse armature bake oven.

This equipment has been in continuous operation for the last six months and results have been very satisfactory. Indications are that there will be just as great an improvement in length of life of our armatures and coils due to this improved method as has been secured by other lines using the same equipment.

The dipping tank is large enough to take care of our maximum size transformer or armature. The varnish used is the best that can be secured for this work. The oven measures 6 ft. by 6 ft. by 6 ft. inside approximate dimensions and is of sheet steel sectional construction insulated with mineral wool on all sides, including doors. Type C oven heaters are mounted on the side walls at the floor line, and the temperature is automatically maintained by a thermometer thermostat, operating a control panel through relays. This is an enclosed panel, and includes relays, contactors and fuses, etc., for 220 volt, 3 phase service. In addition, there is a recording (graphic) thermometer for permanent record of temperatures and a push button station and door switch.



Interior of Baking Oven Showing Roller Conveyor to Facilitate the Handling of Apparatus

In order to guard against a possible failure of the control apparatus, a special thermostat and relay are placed in the oven to shut off the current if the maximum temperature should be exceeded.

The correct temperature for the size of armature being baked is maintained automatically and absolutely uniform distribution of heat is secured at all times. A small motor exhauster set insures the proper amount of ventilation.

In making a survey of street lighting in the United States the poorest average illumination and the highest cost per capita, were found in the smallest cities, the average cost per capita in this group being $1.02 per year. The least cost in any group is 74 cents, in the group having a population range from 150 to 200 thousand. This group has the cheapest and also the poorest lighting of any of the larger cities.

Almost every imaginable combination of municipal and private ownership and operation of lighting plants and equipment is used, and there are few cities in which the lighting system is owned and operated entirely by either the city or a public utility company. On the same street there may be two separate systems between the municipality, merchants and local electric light company.

In groups comprising cities ranging from 200 to 300 thousand, the costs are high and the illumination the best of any group. This group contains the largest percentage of state capitals, five out of the nine cities reporting in this group being capitals.

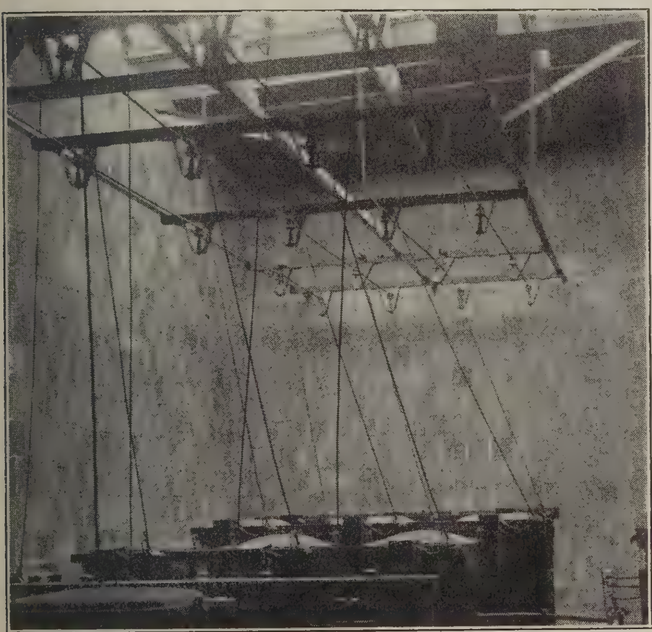
The proportion of arc lights used varies greatly with the size of the city, being larger in the larger cities.

New Car Shop of E. J. & E. Ry. at East Joliet

Improved Method of Segregating Power Circuits—Overhead Lighting Efficient and Easily Maintained

By A. W. Ryan
Chief Electrician, Elgin Joliet & Eastern Ry., East Joliet, Illinois

A MODERN fireproof car shop devoted exclusively to the repair and construction of steel coke cars has recently been completed and placed in service at the shops of the Elgin, Joliet & Eastern Railway at East Joliet, Ill. The building is of brick and steel construction, 550 ft. by 280 ft., and has a capacity large enough to



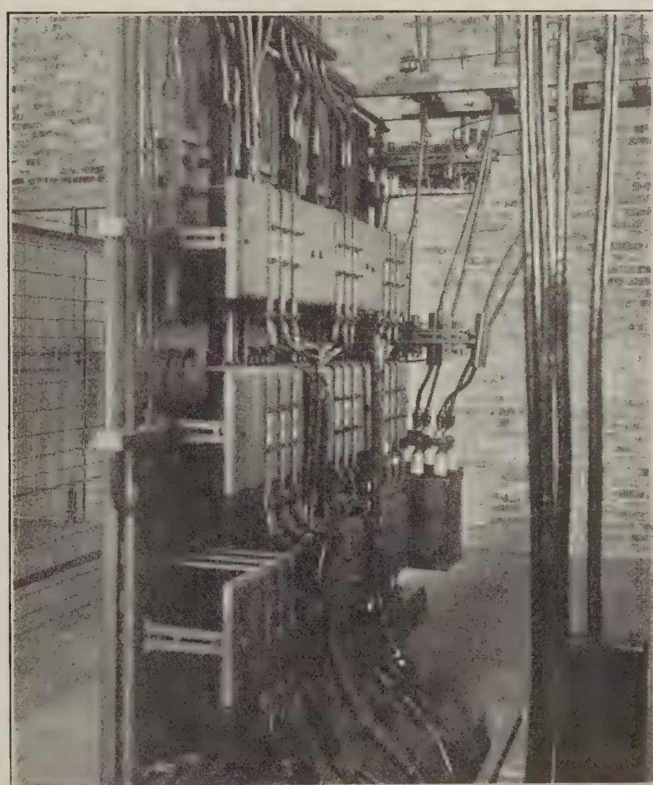
Overhead Bus Wiring in Transformer Vault

handle 50 steel cars on shop tracks at one time. Nearly all the material handling and erecting is accomplished by means of the overhead electric cranes, of which there are 14 installed at the present time. A small narrow gage railroad located in the middle of the shop and running transversely the entire width of the building, enables the quick transfer of steel plates and parts used in car-erection work, between the various overhead cranes, which travel in a longitudinal direction.

Present Power Supply

The shop is at present served from a special 4,400-volt, 3-phase, 4-wire, 60-cycle line connected to the primary distribution system of the Public Service Company of Northern Illinois. The primary wires for all power purposes are carried over to the rear of the left hand panel of the main power control switchboard, located in the engine room, as shown on the floor plan. The lighting transformers, which are located in the same vault as the power banks, are fed direct from the three primary phase wires through taps taken off of the incoming line and leading direct to the lighting transformers. The only control switches for shop lights are the various, steel enclosed, fused type, distribution panels located at various centers in the building. The main power control switchboard, as shown in the illustration, is made up on the unit plan and has four panels, the left hand panel (looking at the front of the board) is the primary control panel, the other three panels are used for controlling the various power circuits in the shop.

The primary control panel has a voltmeter and three ammeters located at the top for determining the load in each phase. A voltmeter selector switch permits the attendant to read each "phase-to-neutral" voltage with only one voltmeter. All instruments are calibrated to read primary voltage and current. A type OA polyphase watthour meter at the base of the panel records the total consumption of energy for power purposes. The primary circuit can be opened by means of a manually operated oil circuit breaker, type F22, 800 amp., 7,500 volt, automatic overload equipped with an under-voltage



Rear View of Main Control Switchboard Showing Unit Panel Construction

release. The secondary control panels are all identical and have, one 200-ampere and two 400-ampere knife switches on each panel, controlling a total of nine separate power circuits. Each panel is a separate unit, there being no horizontal buses in the rear of the board. The three knife switches on each panel are connected to a vertical bus that connects at the top with the cables leading to

the respective power bank for that panel. All fuses are of the open link type and are mounted in the rear of the board for quick replacement in case of trouble. As shown in the rear view of the main control board the circuit numbers are all marked at each fuse, thus making it easy for the attendant to find the trouble. This board is equipped with two type K current transformers of 500 to 5 ampere ratio and three type VS potential transformers of 2000 to 100 volt ratio for operating the meters and the automatic overload and under-voltage release coils: This power board was designed by the writer and furnished by the Westinghouse Electric & Manufacturing Co. The total energy consumption in this installation is 1800 kva.

Transformer Vault Permits Segregation of Power Circuits

A completely enclosed vault of concrete and hollow tile construction above the engine room permits a safe installation and at the same time provides space enough for segregating the major power circuits by installing separate banks for each large unit in the shop. As an example there is a bank of three 100 kva. transformers to feed one of the 250 hp. air compressor drives in the engine room, with enough additional capacity to feed some of the motor circuits in the shop. A small bank of three 15 kva. transformers with two 25 kva. transformers furnished all the lighting current for the entire shop. Each power transformer is equipped with a high voltage fuse of the Matthews type rated at 4400 volts, 60

Overhead Crane in Center Bay. Note Position of Disconnecting Hanger Lamps

amperes for protecting the transformer, as well as for permitting repairs to be made, without cutting out the entire bank. All three-phase power banks are "star" connected on the primary side and "delta" connected on the secondary side. The vault is large enough to take care of additional transformer banks, if any future increase in load should ever make such an installation necessary.

Air Compressor Drives

The shop requires a large amount of compressed air for riveting and cutting hammers. To provide sufficient pumping capacity to handle the demand there are installed four motor driven compressors and an auxiliary steam driven compressor. Two Sullivan compressors are each belt-connected to a 250 hp. General Electric slip-ring induction motor. These are 220 volt 60 cycle type I motors, drawing a full load current of 600 amperes at a full load speed of 585 r.p.m.

Each motor is provided with a separate starting and control equipment mounted on a panel near the motor. The cables leading from the transformer secondaries in the vault are brought down to the motor control panel and terminate in a three-pole, 800 amp. Trumbull knife switch, equipped with two-400 amp. fuses per phase. The primary motor circuit is closed through a three-pole

Arrangement of Contact Shoes on Overhead Cranes

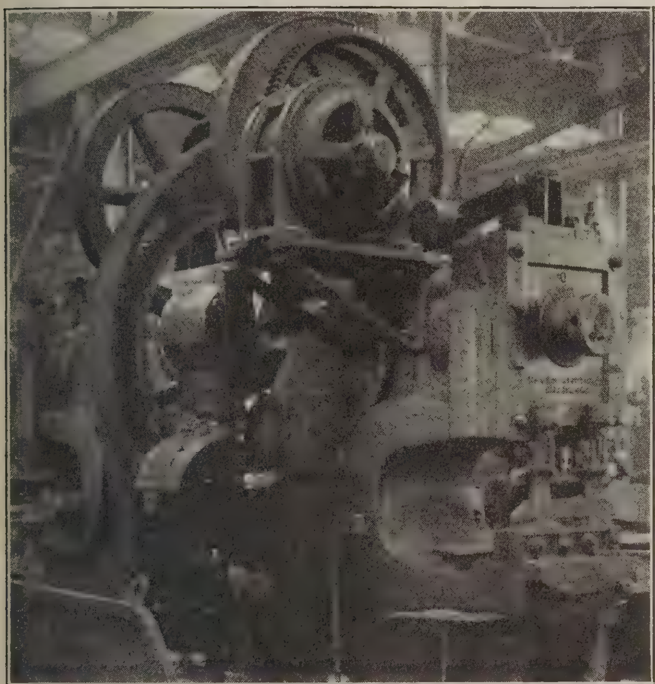
oil circuit breaker at the rear of the panel, mechanically connected for manual operation. The breaker is arranged to open automatically on overload, through inverse time limit relays (type PQ3) or on low voltage, through an under-voltage release attachment. The inverse time limit feature on overload avoids unnecessary interruptions in service from heavy overloads of momentary duration, however if the overload is sustained, the circuit breaker opens within a period determined by the time setting of the relay. The time delay in the operation of the relay is inversely proportional to the amount of the overload current. The under-voltage release provides for opening the circuit breaker in the event of a sudden drop in voltage or a total failure at the supply mains. This release is effected by a hinged armature which falls open by gravity when the voltage of the supply mains drops to approximately 50 per cent of normal or when the under-voltage release circuit is opened by the operation of some other device. The armature in falling, trips a spring actuated trigger which acts directly on the tripping mechanism of the breaker operating lever. The actual tripping effect is accomplished through a spring and not by gravity.

The motor secondary circuit is provided with a starting controller of the drum type connected to a five box resistor bank. To protect the motor as well as the starting resistors a special interlock feature is provided which prevents closing the oil circuit breaker unless the con-

troller is in the "off" position. This starting protection is secured by breaking the under-voltage release circuit through a pair of contacts on the controller, closed in the "off" position.

An ammeter mounted near the top of the motor control panel enables the operator to determine the motor load at any time.

The two other motor driven compressors in the engine room are of the Ingersoll-Rand Imperial type, belt-connected to 200 hp. G. E. slip ring induction motors. The control features for these two drives are almost identical with the two Sullivan air compressor drives previously described. The panels are not equipped with ammeters



Motor and Control Equipment for Combination Punch and Shears

or with inverse time limit relays for overload protection, the regular overload trip mechanism on each breaker is relied upon to open the circuit under all conditions.

At the present time all rivet heating furnaces are oil fired, but are furnished with forced draft, from a motor-driven blower in the engine room. This blower is driven by a 40 hp. Howell "Red Band," 220-volt induction motor, with a Cutler-Hammer auto-transformer starter and Square "D" safety switch.

All the air compressor motors with auxiliary control equipment located in the engine room as well as most of the machine motors throughout the shop are of General Electric manufacture.

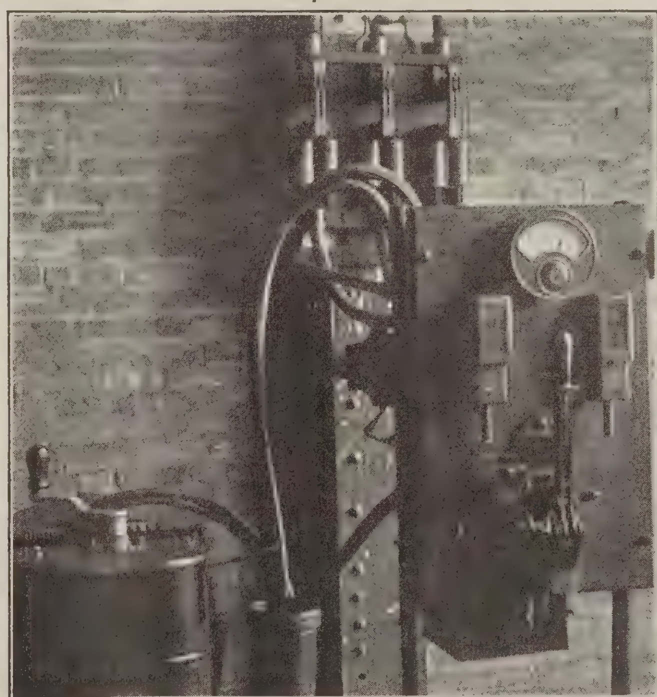
The car shop is equipped with several large punches and shears for handling heavy work. Polyphase induction motors of the squirrel cage type are used exclusively for all machine drives. The motors are controlled by G. E. starting compensators, type CR-1034, in combination with G. E. safety enclosed, lever switches. All compensators have the usual push button stop feature.

Overhead Traveling Cranes

The current collecting system used by the overhead cranes is somewhat different from the usual type of construction. No trolley wires are used for feeding the cranes, an arrangement somewhat analogous to a third rail system being used instead. Three angle-iron current conductors spaced vertically and fastened to the web of the supporting I-beam constitute the "third rail" system. Contact shoes are carried on the crane and these permit uninterrupted current collection under extreme end play which is a factor of considerable importance. All cranes are 6 ton capacity and manufactured by the Milwaukee Electric Crane & Mfg. Co. Each crane has 3 motors, a 15 hp. bridge motor, a 3 hp. carriage motor and a 15 hp. hoist motor. All motors and controllers are built by the crane manufacturer.

Narrow Gage Railroad Permits Rapid Transfer Between Overhead Cranes

The arrow gage railroad, previously referred to, was designed to allow quick transfer of steel plates and other steel parts used in car building, between the various overhead cranes. However the movement of material on the narrow gage railroad is not limited to transverse travel, as a great many switches are installed which provide for narrow gage traffic in a direction parallel to the crane runways. The storage battery locomotive operating over the narrow gage tracks was manufactured by the Automatic Transportation Co., Buffalo, N. Y. Exide storage batteries furnish the motive power for operating the locomotive. These locomotive batteries are charged by a



Control Equipment for 250 hp. Slip Ring Induction Motor Drive for Sullivan Compressor

special motor generator set rated at 65-67-volts, 60 amp. manufactured by the Electric Products Co., Cleveland, Ohio.

All Cables Installed Underground

Power and light cables are lead-covered and laid in fibre duct encased in concrete beneath the shop floor as shown in the diagram of manhole locations. The duct lines are built of 3 in. Bermico fibre duct laid in concrete with a 2 in. wall between adjacent ducts. In order to enable one to form some idea of the amount of cable

involved in an installation of this kind, the following table is a list of all lead-covered cables used in the car shop. This list also includes cable which has been installed to handle carbon arc burning equipment which will likely be in service in the future to supplant the air hammers and oxy-acetylene torches now in use.

UNDERGROUND LEAD CABLE.

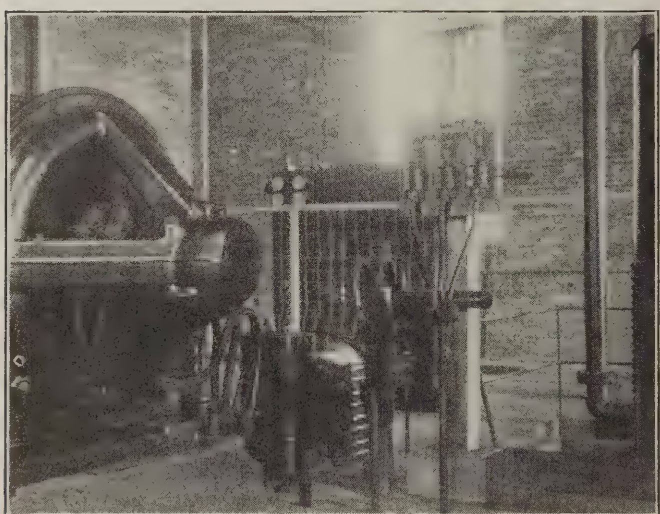
1. 1,200 ft.—1,500,000 c.m.—single conductor stranded.
2. 800 ft.— 700,000 c.m.—single conductor stranded.
3. 300 ft.—No. 4/0 A.W.G.—3 conductor stranded.
4. 1,200 ft.—No. 3/0 A.W.G.—3 conductor stranded.
5. 2,000 ft.—No. 2/0 A.W.G.—3 conductor stranded.
6. 1,050 ft.—No. 1/0 A.W.G.—3 conductor stranded.
7. 500 ft.—No. 1 A.W.G.—3 conductor.
8. 300 ft.—No. 4 A.W.G.—3 conductor.
9. 500 ft.—No. 6 A.W.G.—3 conductor.
10. 400 ft.—No. 8 A.W.G.—3 conductor.
11. 1,100 ft.—No. 8 A.W.G.—2 conductor.
12. 300 ft.—No. 8 A.W.G.—3 conductor stranded.

All lead-covered cable was supplied by the Western Electric Co. and American Steel & Wire Co.

Lighting System Designed for Low Maintenance Cost

No portable drop lights are used in car building or repairing; the overhead drop lights and bracket lights mounted on the columns for illuminating the sides of the cars furnish enough light for this purpose. The lighting and conduit plan shows the location of all the overhead drop lights and bracket lights as well as the location of drop cord receptacles used in making machine repairs.

One of the most important items of maintenance in any lighting installation is the matter of proper and frequent inspection and cleaning of reflectors and lamps.



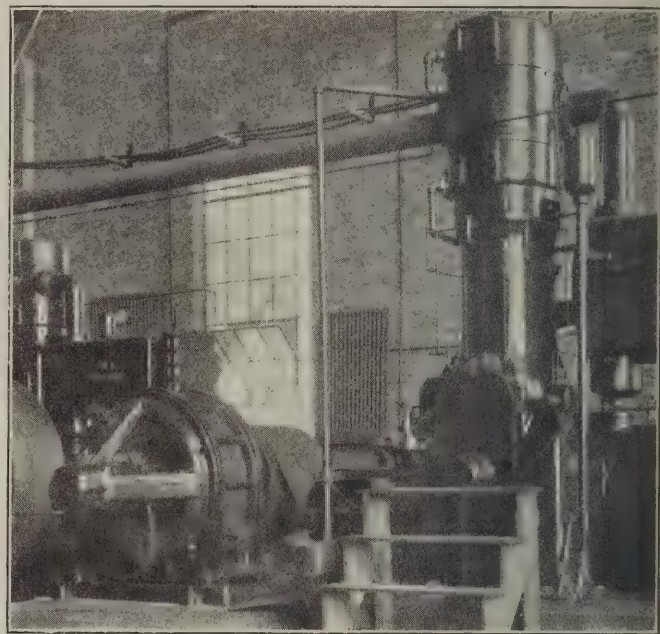
One of the 200 hp. Slip Ring Induction Motors and Control Equipment for Ingersoll-Rand Compressors

The overhead cranes required that any overhead system of lighting be at least 30 ft. above the ground to clear the top of the cranes. To maintain properly an overhead system would be very expensive were it not possible to lower the lighting units to floor level to permit cleaning. The overhead drop lights are fitted with Thompson safety disconnecting hangers, Ivanhoe standard type reflectors REB No. 500 and 300-watt lamps.

The bracket lights are placed 15 ft. above the floor and are fitted with Ivanhoe reflectors type REL No. 500 with 200-watt lamps. One man with a step ladder can easily clean these lights.

Modern sanitary wash rooms and steel locker facilities are provided for the employees and both rooms are well lighted with Ivanhoe Glassteel diffuser reflectors and 300-watt lamps. The car foreman's office and the electric repair shop and storeroom are equipped with direct lighting enclosed ceiling units and 200-watt lamps. All lights in the shop are controlled by Westinghouse type, dead front, panel board switches, with steel enclosure cabinets. All live parts are completely enclosed and the fuse panel locked to prevent unauthorized persons from tampering with the fuses.

Not more than two circuits of No. 12 A.W.G. rubber



A 250 hp. Slip Ring Induction Motor Belt Connected to Sullivan Compressor

covered wire were installed in a ¾ in. conduit. All wire for overhead drop lights and bracket lights is Crown Duplex, No. 434, furnished by the American Steel & Wire Co.

Electric Locomotive Built in Piedmont & Northern Shops

THE Piedmont & Northern Railway Company recently placed in freight service a unique electric locomotive designed and built by the railroad forces. This company operates passenger and freight service over some 100 miles of track through the Piedmont section of the two Carolinas. The motive power used is direct current drawn from a 1,500-volt trolley.

The locomotive is of the articulated type with a single cab. It measures 64 ft. between the coupler knuckles and has a wheelbase 54 ft. 8 in. long. The overall height is 15 ft. 5 in. and the width is 9 ft. 10 in. The total weight is 95 tons. The running gear consists of four Baldwin motor trucks having 36-in. wheels with 7-ft. wheelbases. Each pair of trucks is swiveled under a rigid box girder center beam, the two beams being linked together at their inner ends. The outer ends are built up with necessary side and cross members to carry the platforms, bumper beams, draft gear, etc. Each axle carries a motor; there are eight pairs of driving wheels with all the weight of the locomotive on the

drivers. The roomy steel cab, measuring 46 ft. 9 in. in length, is carried on two main bearings pinned to the center beams and is so located as to give proper distribution of weight to each of the four trucks. On each side of the center are two floor stringers consisting of 8-in. channels running the full length of cab. A plate riveted across the bottom of the channels forms the side walls of air ducts in the forced ventilation system for the motors. Except for the plates above mentioned, which have openings leading to the motors, none of the longitudinal members of the cab is bored for passage of pipes or conduit.

The grid chamber, located in the middle of the cab, runs from the floor up through the roof. It is open below and covered by a monitor roof, thus being afforded ample ventilation. This chamber is particularly roomy and grid frames are so arranged that any one of them can be readily removed without disturbing the others. All equipment in the cab is located so as to be readily accessible for inspection and repair and any unit can be removed without moving any other. All wiring is in conduit and each circuit is made as short as possible. Double-end operation is provided.

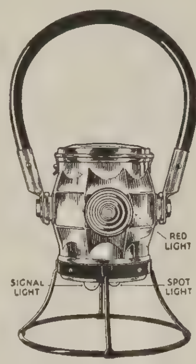
The electrical equipment, supplied by the Westinghouse Electric & Manufacturing Company, consists of eight 145 h.p. motors and type H.L.F. control. Low voltage for operating the switches, reverser, etc., is supplied by two dynamotors. These are type Y E — 6 dynamometer air compressors which deliver 100 cu. ft. of air per minute.

The control apparatus consists of two type 65-C-13 line switches, two type 65-B-27 switch groups and two type 84-C reversers, together with other auxiliaries necessary for electro-pneumatic control. The motors are ventilated and cooled by force draft ventilation. All motors are inter-pole type with field control thus providing four running points instead of the two that are found in ordinary equipment.

The locomotive will develop 39,000 lb. tractive effort and will handle from 1,000 to 1,400 tons trailing load at 20 miles an hour.

Electric Hand Signaling Lantern

An electric hand lantern, incorporating several unique features, has been placed on the market recently by the Economy Electric Lantern Company, Chicago, which was designed primarily for the use of trainmen. It has two white lights on the bottom of the lantern body, one of which may be used as a spot light, being fitted in a polished reflector for work requiring a concentrated beam of light, such as reading car numbers, etc. The other white light mounted on the bottom face of the case is more diffused and is used for hand signaling purposes and general illumination.



Electric Hand Lantern

As another special feature, this lantern also has a red light on one side fitted with a "beehive" lens. It is claimed that this red light can be seen further than ordinary red lanterns using oil, and is therefore more efficient for flagging. Both the red and white lights can be burned at the same time or either can be burned alone as the occasion requires. As this electric lantern has both the white and red lights, it may be used to replace the two oil lanterns which are ordinarily required for flagging, thus making it a full service white and red lantern.

The body of the lantern is formed of one piece of seamless sheet brass, nickel-plated if desired. The base is of rustproof steel with frosted enamel finish. The handle is made of seamless aluminum tubing covered with fibre. This handle swings on ratchet bearings and is held in each position by springs. A standard lantern size dry cell battery is used. The three light bulbs, of the same size and type, are interchangeable. Inside the nest is an extra socket in which an emergency bulb may be carried if desired.

The Chicago & Alton at the present time is conducting an extensive operating test of this lantern for the use of trainmen.

The Cab of the Locomotive Rests on an Articulated Frame Which Is Supported in Turn by Four Swivel Trucks

Locating Defects in Armatures

For testing armatures a very convenient device was recently described in an issue of the Industrial Engineer. It consists of two dry cells, an ordinary buzzer and a telephone receiver. The diagram of connections is given, showing the manner in which the apparatus is used. For the sake of convenience and protection the batteries and buzzer may be enclosed in a box, and inasmuch as the telephone receiver is also part of the equipment, it may be just as well to provide room for it in the same box.

Two 3-foot leads are brought out from the box, one of these leads containing a single pole switch as shown in the illustration. The insulation is skinned off for about an inch at the ends of the leads, which are fastened to a piece of strong cord.

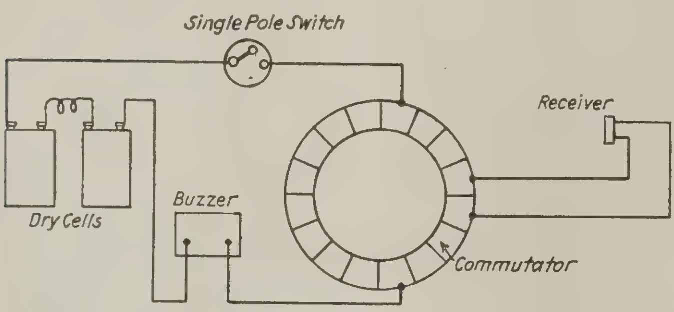


Diagram Showing How Tests Are Made

When making a test the cord is tied around the commutator holding the ends of the bare leads at points which are separated from each other by from ten to twenty bars, depending on the resistance of the coil and the number of bars on the commutator. The leads of the telephone receiver are then placed on adjoining bars, between the points and the character and intensity of the buzzer sound is noted in the receiver. Each pair of bars between the buzzer points are then tested in succession.

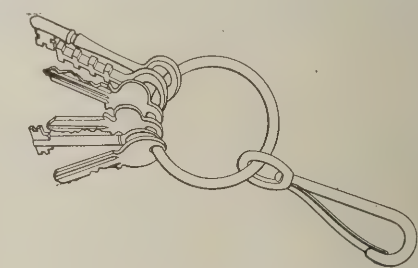
If the same sound is noted from all of the bars, the armature can be safely relied upon to run. If a low sound or no sound at all is obtained, a short circuit is indicated. A sound which is louder than usual indicates an open circuit. A cross or transposed lead will sound like a shorted coil; that is, it will give either a low buzz or no buzz at all. A grounded coil can be located by putting one of the receiver leads on the shaft and then moving the other from bar to bar and noting where the sound is lowest. The bar that has the lowest sound is usually connected to the ground coil.

A shorted or grounded coil in a stator can be located with a buzer by touching the ends of the buzzer leads on the stator and then testing the individual coils in the same manner as the bars of the commutator.

This method has been found to be about as accurate as the use of milli-voltmeter or other testing instruments. At the same time it is generally easier and quicker than most other methods, and the set has the further advantage of being light and easy to carry.

Handy Way to Carry Keys

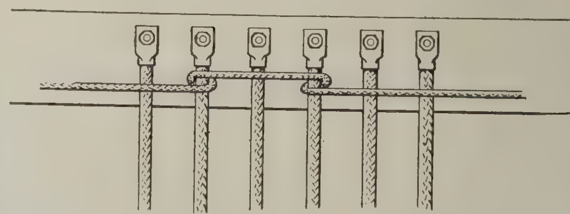
A handy way of carrying your keys can be rigged up easily by slipping a small harness snap on a key-ring with the keys. The keys can then be carried by snapping the snap onto the buckle of your overalls or if you wear a belt, an extra ring can be worn over the belt and the key snapped to it. This method allows one to find the keys quickly, especially during the winter, when one does not want to remove gloves every time the keys are needed.



A Harness Snap Makes a Useful Addition to a Full Key Ring

Keeping Disconnected Wires Apart

When making the changes or tests in terminal boxes where a number of wires are to be disconnected, there is a possibility that the bare ends of the wires may touch together, thus causing a short circuit or sending current where it should not go. Before making any disconnections



By Using a Small Piece of Insulated Wire as Shown Wire Terminals Can Be Kept Apart When Disconnected

it is a good idea to run a small covered wire, say a No. 12 or No. 16, up along the terminals and give one turn about each wire that is to be disconnected as near the connection as possible. It will be found that the separator will prevent the wires touching and thus avoid considerable trouble.

Laugh!

Build for yourself a strong box,
Fashion each part with care;
Fit it with hasp and padlock,
Put all your troubles there.
Hide therein all your failures,
And each bitter cup you quaff,
Lock all your heartaches within it,
Then—sit on the lid and laugh.

Tell no one of its contents;
Never its secrets share;
Drop in your cares and worries,
Keep them forever there.
Hide them from sight so completely
The world will never dream half.
Fasten the top down securely,
Then—sit on the lid and laugh.

Hard Work

"Where are you men going?" the new boss demanded of two darkies who were shuffling along as if bent on nothing in particular.

"Boss," said one, "we is gwine up to de mill with this plank?"

"Plank! I don't see any plank!" roared the supervisor.

Not at all disturbed by his tone, the speaker looked down at his hands, then over his shoulder. Finally, to his fellow worker, he calmly observed:

"Well, now, don't dat beat all! Ef we ain't gone an' clean forgit de ole plank!"

Calling the Caller

Yardmaster (to Caller)—"Did you call Murphy up this morning?"

Caller—"Yes, but he wasn't down."

Yardmaster—"But why didn't you call him down?"

Caller—"Because he wasn't up."

Yardmaster—"Then call him up now and call him down for not being down when you called him up."

Answers to Questions

1. *How is a slide wire bridge used?*

The Use of a Slide Wire Bridge

A slide wire bridge such as was described in last month's question corner may be successfully used to measure resistance from 0.1 ohm to 1,000 ohms with a very fair degree of accuracy.

The bridge itself is really nothing more or less than a special form of Wheatstone bridge and its operation may best be explained by assuming a test to be made of a certain unknown resistance.

To begin with it is rather important to have some idea approximately what the value of the resistance is, that is, whether it is less than 1 ohm, or between 1 ohm and 100 ohms, or more nearly 1,000 ohms. Of course, if nothing is known about the resistance to be tested at all this information will be acquired shortly after the test is begun, as the best spool to use will be soon found.

A spool of known resistance is inserted in the terminals *C* and *D* Fig. 1 and the unknown resistance is connected to the terminals *F* and *G*. The battery is connected across binding posts *A* and *B* and one of the galvanometer terminals to the post *E*. The other galvanometer terminal is connected to a flexible wire slider. The slider is moved along the wire *A B* until some point as *K* is found where the needle is not deflected. This indicates that a balance has been obtained and the calculation of the unknown resistance is then made from the formula.

Unknown Resistance =

$$\frac{\text{Ohms in Known Res. Spool} \times \text{length K B}}{\text{length A K}}$$

For example, suppose you are required to measure a resistance of a spool of wire which rough calculations indicate as approximately 20 ohms. When inserted in the

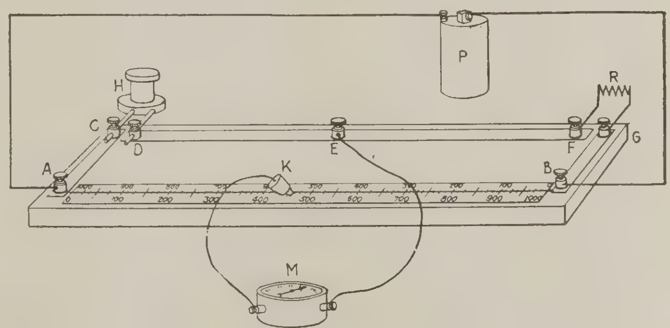


Fig. 1.—Slide Wire Bridge Showing Testing Connections

bridge the following data is recorded when the balance is obtained: the 10 ohm spool was selected; A K = 350 scale divisions from the left hand zero mark, and K B = 650 scale divisions from the right hand zero mark. Substituting these values in the formula we have the unknown resistance $= \frac{10 \times 650}{350} = 18.57$ ohms. In the same manner other unknown resistances may be measured. It is well to keep in mind, however, that the best results will be obtained when the known resistance spool is somewhere near the value of the unknown resistance.

Questions for April

1. *Can I charge a 6-volt battery from city current which is alternating?*

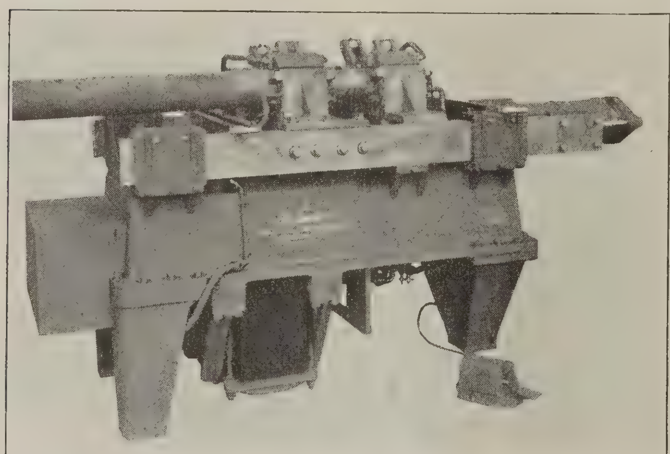
2. *How high can I run up the specific gravity when the battery is down to* 1,100?

3. *Which is the best current, a. c. or d. c., to charge with?—K. W. C.*

NEW DEVICES

Resistance Welder with a Water-Cooled Transformer

A resistance welder with a water cooled transformer for welding locomotive superheater tubes has been designed and built by the Federal Machine & Welder Company, Warren, Ohio. The machine is supplied with a remote control magnetically operated switch, so designed that the metal contacts are readily removed and replaced with slight expense. The switch has asbestos-wood flash plates, to prevent the arc from blowing out from the contacts when the circuit is open under heavy load and is also supplied with magnetic blow-outs, which extinguishes the arc. The switch is mounted on a heavy slate base, which is installed in a steel box, having a door arranged for locking, to avoid tampering with the switch. A small shunt switch is supplied as part of the regular equipment. This

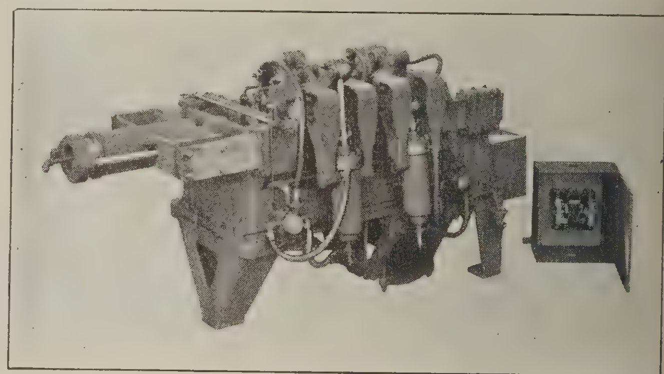


Welding a Locomotive Superheater Tube in a Federal Butt Welder

is mounted directly on the operating lever, or at a convenient point on the welding machine.

The machine is supplied with a cylinder of the proper dimensions to give pressure capacity at the welding jaws of 3,000 lb. per sq. in. up to the given capacity of the machine, or the cylinder will have a capacity to apply 13,400 lb. pressure at the welding jaws, when supplied with 1,800 lb. pressure on the hydraulic line.

The transformer consists of heavy cast copper secondaries entirely surrounding the core and insulated from it with bakelite strips. Each section of these secondaries is supplied with a water cooling pipe which extends through its entire length. The secondaries are divided into three sections which are placed between four primary coils. The primary coils are wound with copper ribbon, the turns of which are insulated from each other with oiled muslin and asbestos ribbon. The coils complete



Rear View Showing Air Cylinders and Remote Control Switch in Steel Box

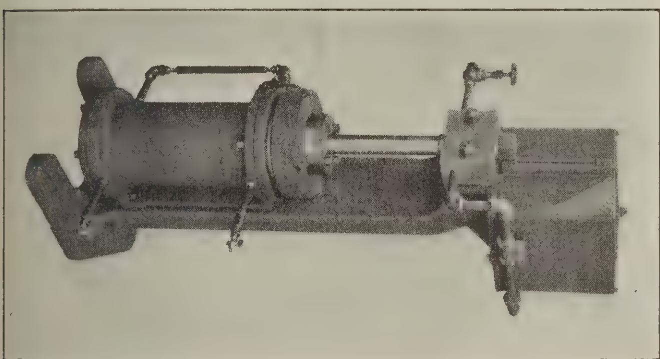
are covered throughout with asbestos tape to make them fire and water proof. The insulation between the primary and secondary coils consists of a flexible material made up of asbestos fibre ⅛ in. thick, which has a break-down test of 20,000 volts. The entire set of transformer coils is mounted on the transformer core which is machined in sections, and the coils can be readily removed, in case it is desirable to dismantle the transformer. The core is made of high silicon, non-ageing transformer steel, having a low core loss. The entire equipment is air cooled. If the welders are equipped with a 100 kva capacity transformer it will have sufficient capacity to weld continuously 4½ sq. in. of metal.

The transformer is mounted under the movable main platen or slide in such a manner that it is impossible for dirt, flash or refuse coming from the weld to get in the windings of the transformer. It has been found that with the transformer located directly underneath the gap between the movable slides, the flash or throw-up from the weld falls directly on it and the strong magnetic pull induced by the secondary under the flow of the immense amperage has a tendency to pull the metallic dust into

the windings, finally resulting in burn-outs or short circuits. It is claimed that this difficulty has been entirely eliminated in this machine as the transformer is not located under the slides and is further protected by a heavy slate slab, which extends directly from the under slide of the platen down nearly to the floor. The only parts of the electrical secondary that are exposed to the throw-off from the weld, are three heavy copper secondary connections, which extend to the left hand stationary electrode.

The welding machine has a three point bearing, that is, two legs on one end and one on the other. The four legged construction, unless very carefully installed, throws a twist in the machine, resulting in a binding of the slides and unsatisfactory work due to improper alinement.

The main movable platen or slide is carried on two heavy steel bars which extend the full length of the machine, giving a bearing between the sliding contacts of



Hydraulic Intensifier Used with the Butt Welder

approximately 5 ft. 6 in. and at the same time placing the main bearings at the extreme ends of the machine where they are entirely out of the way of dirt and flash which is thrown off at the weld.

The transformer being supported directly under the movable slide and not enclosed in an oil-cooled case, is readily inspected and accessible for blowing out of whatever dirt may accumulate after long use. The main bearings which are of heavy steel construction are located at the outer ends of the machine and are easy to adjust and are arranged for proper lubrication by means of the Alemite system. An Alemite grease gun to lubricate all of the moving parts is supplied with the welder.

The machine is constructed with dies of the circular pattern design, held in position by wedge shaped clamps. The dies are located in holders which are supplied with water-cooling pipes. The water is permitted to flow through these holders at all times when doing heavy work, or handling the machine up to its full capacity. The pressure in clamping the pipe is applied with the aid of a toggle lever and air operating cylinder, eliminating the labor necessary in clamping large size pipe by hand. The actual pressure applied when clamping tubes is approximately 16 tons on each clamp. The circular shape of the dies provides proper alinement at all times.

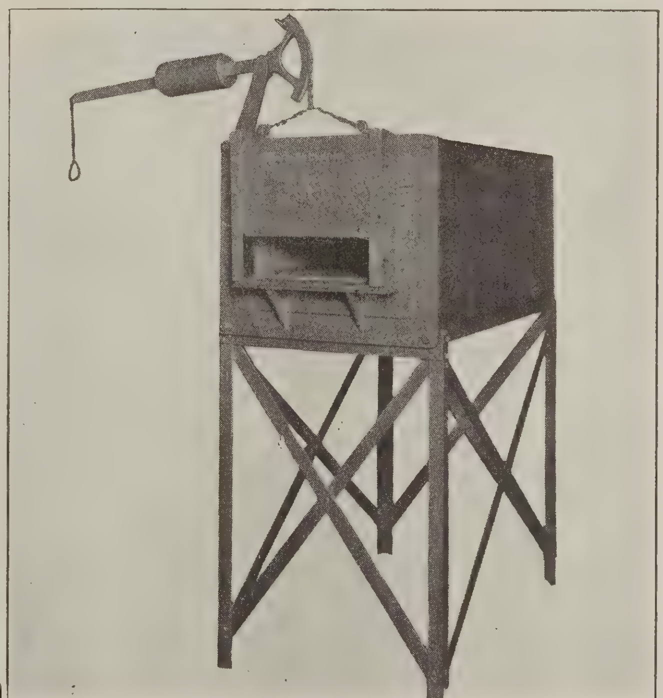
The construction of the machine is such that the disposition of the frame to buckle is a remote possibility. The operating cylinder is so installed that a straight pull is applied to the moving platen and this, with the aid of the long bearing, eliminates the tendency to spring the bed plate.

Electric Furnace with Perforated Muffle Plates

A new industrial hearth-type electric furnace for operation up to 1,850 deg. F. has been recently perfected by the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. These furnaces, which are known as type B, are made with hearth sizes ranging from 4 in. wide and 10¼ in. deep to 12 in. wide and 36 in. deep and are particularly well suited for such operations as annealing, hardening, tempering, normalizing, carbonizing and case hardening. Automatic temperature control makes it possible to duplicate heating conditions as often as is necessary.

One of the distinctive features of this furnace is that the muffle plates, which completely enclose the heating chamber, are perforated so that heat is radiated directly from the heating element to the charge. This unusual construction permits a higher temperature in the heating chamber without undue deterioration of the heating elements. These elements, which consist of S-bend coils of nickel-chromium wire, are placed on all four sides of the heating chamber and are supported and alined by molded studs on the muffle plates.

The door of the furnace is suspended by a chain from one point, which, being always on the circumference of an



Electric Furnace Equipped with Automatic Temperature Control

arc at the end of the operating handle, maintains a position directly over the center of the door when it is opened or closed. This method of operation prevents the door from sticking or jamming in its guides. Pieces of angle iron bolted to the guides are so adjusted that the door is held closely aaginst the front casting when closed but can move easily when being opened.

The insulation of the furnace is arranged so that the muffle plates do not carry any of the weight. Standard insulating bricks next to the shell are supported by the high temperature insulation, which is in the form of slabs.

In this way, the muffles are relieved of the weight of the insulation.

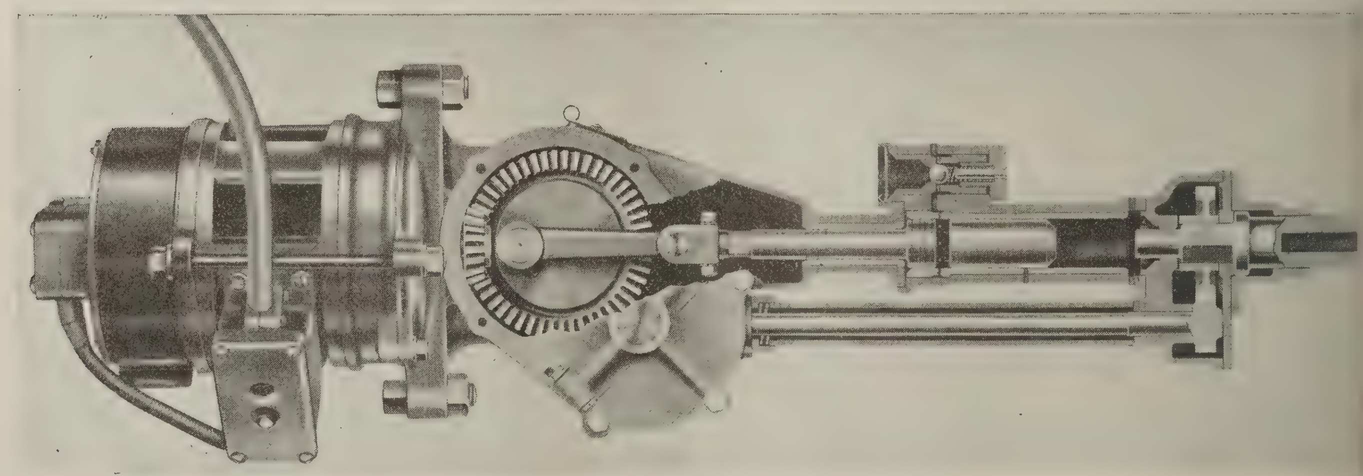
One of the advantages of the electric furnace is its automatic control, enabling the operator to maintain a desired temperature indefinitely. The automatic electric control consists of a control pyrometer, a relay and magnetic contactor. In the control instrument, a stationary pointer carrying two electric contacts is set at the desired temperature and the furnace turned on by a conveniently located push button. As the temperature rises, an indicating hand in the control instrument, actuated by a thermocouple in the furnace chamber, moves along the scale. When it reaches the upper of the two contacts carried by the stationary pointer, the relay is energized, opening the magnetic contactors and cutting off the current. When the temperature falls to the point where the indicating hand reaches the lower of the contacts on the stationary pointer, the relay cuts the current on again. This cycle, continuing as long as the furnace is in operation, maintains the temperature within approximately one per cent of the desired point without any attention on the part of the operator.

An Ingenious Electric Drill

The Pneumelectric is the appropriate name of a drill of the hammer or percussion type in which the rotary motion of the electric motor is transmitted into the straight, sharp strokes of the hammer through the agency of the compressed air device interposed between the motor and the hammer. The machine will be best understood by a study of the drawing which shows a longitudinal section through the machine from the base or flange to which the motor is attached to the holder for the drill bit or chisel. Here it is seen that the machine consists of a gear drive by means of which the motor actuates the piston, a combined dolly and chuck for attaching the drill bit, with a floating cylinder or hammer occupying the space in the barrel between the piston and the dolly but without any mechanical connection to either of them.

Briefly, the operation of the machine calls for the compression of air to the rear or left of the piston which is suddenly released, driving the hammer forward and causing it to strike the chuck, the important element in the success of the device being that the compressed air must be applied at the time of its maximum compression so as to drive the hammer forward suddenly with the greatest force. On the forward movement of the piston the air is drawn into the cylinder behind the piston through the intake valve mounted on top of the barrel. On the backward motion of the piston this valve is closed and the air is compressed to the rear of the piston at the same time that the hammer is drawn back by atmospheric pressure from air entering through the holes in the forward end of the barrel while a partial vacuum is being formed to the left of the hammer with the withdrawal of the piston to the left. Just as the piston clears the port at the rear end of the barrel in its movement to the left, the compressed air to the left of the piston is permitted to bypass around the piston and is released into the space between the piston and the hammer which, of course, has the effect of driving the hammer to the right and causing it to strike the dolly chuck, transmitting the force of its blow to the drill or cutting steel. As soon as the hammer has moved far enough to clear the intermediate port the compressed air behind it is allowed to escape until the piston, which follows the movement of the hammer to the right, closes this port. The operation is then repeated.

Another feature of the machine is a gear connection from the motor to the chuck which provides for the rotation of the chuck when drilling, this feature being made inoperative when the machine is used for chipping. The motor can be operated from either direct or alternating current circuits of 110 to 125 volts. It strikes an average of a thousand blows per minute. This machine has been in service for the last three months and is said to have given good satisfaction where is was employed on work within its capacity. It is being manufactured by the Pneumelectric Corporation, Syracuse, N. Y.

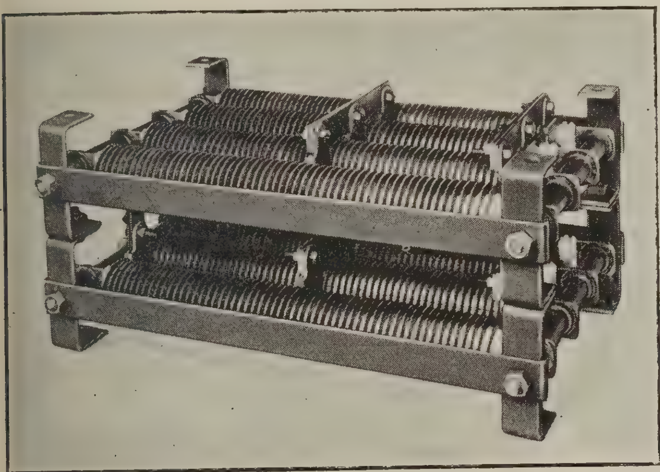

An Interior Longitudinal Section of the New Drill

Edgewound Resistor

A ribbon-type resistor, wound on edge, has recently been developed by the Monitor Controller Company, Baltimore, Md., being intended for service where cast-iron grids would otherwise be employed. It is known as the Monitor Edgewound Resistor and consists of a high-resistance alloy ribbon wound on edge in helical form and

mounted on a steel-reinforced porcelain support which passes through the entire length of the unit, supporting and separating each turn at two diametrically opposite points. This method of construction relieves the resistor ribbon from mechanical strain and permits of thorough ventilation. The ribbon can operate at any temperature up to red heat without sagging or injuring the resistor as a whole.

A system of terminals and taps enables a unit to be connected into a circuit, and to be interconnected with other units. Two simple forms of clamps provide these facilities. One is a bridging clamp which makes solid mechanical connection between two adjacent units and which serves as a terminal when the units are connected



A Bank of Eight Units in the Standard Mounting

in parallel and also as an end tap, if desired, when the units are connected in series. The other may be used for either of two purposes—as a terminal clamp or as a tap. The taps may be placed at any desired point along the resistor and may be changed at will. This permits of accurate adjustment of the resistance steps.

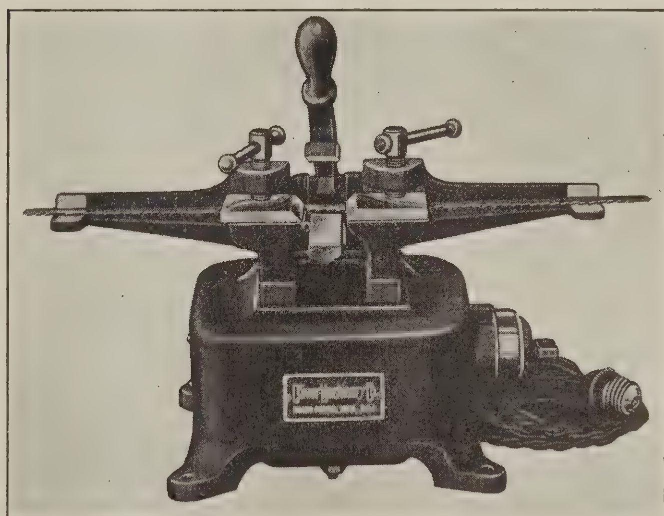
Monitor Edgewound Resistors are made in standard units and mounted in frames so that they can be applied in a manner similar to the usual cast-iron grids. The standard section will contain either four or six units mounted horizontally and connected either in series or in parallel. Any number of these sections may be mounted one on top of another. It makes practically no difference whether the resistor as a whole is mounted with the units in a vertical or horizontal position. There are no joints in a resistor section except at the terminals. On the basis of air temperatures as permitted by the Underwriters, an Edgewound resistor unit will dissipate 75 watts per inch of length.

Non-Metallic Armored Cable

Patents were recently granted to the Rome Wire Company on its new non-metallic armored cable known as Romex. The manufacturers believe that when the Underwriters approve of the use of Romex, this wire is destined to fill an important place in the electrical wiring field. Under the broad claims of the patent as issued, the company feels it is now in a position to guarantee to the industry a high standard of quality of this product, not only as manufactured by it, but also by such other manufacturers as may be licensed to operate under the Rome patent.

Electric Brazer for Band Saw Blades

The Oliver Machinery Company, Grand Rapids, Mich., has recently put on the market a device for brazing band saws which utilizes the electric heat of resistance for melting down the soldering metal. This eliminates any open flame, the danger of fire, and the formation of scale on the saw blade is prevented by a sensitive control of the heat. The device comprises a transformer of which the main coil is connected to a power or light circuit through a switch, and a secondary coil which serves as a stay for both saw ends. The saw ends are beveled to about ⅛ in. to ½ in. Then a strip of ½-in. to ¾-in. silver solder is laid between them and the apparatus is started by turning the switch. After some seconds the brazed seam will glow and melt down the brazing metal. Besides the zero position the switch has three further steps. By every step certain windings of the secondary coil are switched in and off thus causing a stronger or less intense heat. The switch can be regulated both backward and forward thus permitting of regulating the heat conduction during the melting period. After this, the brazing metal is distributed on both sides by means of a borax flux so as to obtain a tight connection and a clean brazed seam without any scale which is a desirable feature.



The Oliver Electric Brazer Greatly Simplifies the Operation of Brazing Band Saw Blades

By means of the hawkbill, both saw ends to be brazed are firmly pressed together for some seconds after the brazing metal has been melted down, but this should only be done after the current has been switched off. There is no annealing of the saw blade. Too great hardness of the steel is prevented by again switching on the electric current.

The brazing process can be easily supervised by the workman, as no flames or dangerous temperatures are produced and damage to the apparatus by wrong attendance is excluded. It requires from six to twelve amperes at 110 volts for blades up to a width of two inches so that it can be connected to every alternating current feeder.

General News Section

The Canadian National will soon establish a new radio broadcasting station at Vancouver, B. C., similar to those that it now operates at Montreal, Toronto, Winnipeg and other points.

The Elwell-Parker Electric Company, Cleveland, Ohio, has appointed J. P. Lyons, 612 Citizens and Southern Bank building, Atlanta, Ga., its district engineer for the territory continguous to Atlanta.

The Strom Ball Bearing Manufacturing Company, Chicago, announces the appointment of Arthur W. Weise, as manager of the company's Philadelphia office. Mr. Weise's headquarters will be at 309 Lincoln Building.

The machine shop of the Delaware & Hudson, Carbondale, Pa., was damaged by fire on the evening of March 20; estimated loss including a number of machine tools, $30,000. The fire is believed to have started from defective wiring.

Ten robbers, with a motor boat, succeeded in stealing nine cases of silk on the 26th street pier of the Lehigh Valley Railroad, New York, on the night of March 22. They surrounded and overpowered the single watchman, and got away in short order. The silk was valued at $40,000.

The Master Electric Company, Dayton, Ohio, manufacturers of electric motors, has recently purchased property at Linden avenue, formerly owned by the Davis Sewing Machine Company. The transfer includes a three-story modern concrete factory building with approximately 60,000 square feet of floor space.

The shops of the Pennsylvania Railroad at Sunbury, Pa., according to report, are soon to be closed. These shops, employing about 500 men, have been in operation since 1876. Reports say that the skilled workmen will be employed by the road at other places. The Sunbury shops are not equipped for repairing modern large locomotives.

The Interstate Commerce Commission has issued orders extending the time for fulfilment of its automatic train control order in the case of the Central of New Jersey and the Chicago, Milwaukee & St Paul to July 1, 1925. The commission had denied an extension for the Central of New Jersey but on petition of the company reconsidered its action.

The Electric Storage Battery Company, Philadelphia, Pa., has bought land as a site for a factory branch to be built in Boston, Mass., on Ashford street, near Babcock. The new building will cover about 35,000 sq. ft., and will consist of a two story office fronting on Ashford street, with a one story manufacturing establishment in the rear. It will be of modern daylight construction and the equipment will be modern in every respect.

Five persons were arrested as railroad car robbers and 25 as receivers of stolen property on March 6, by the police of Harvey, Ill., and detectives of the Chicago, Milwaukee & St Paul, the Chicago, Burlington & Quincy, and the Grand Trunk Western Lines. The men had been stealing property from cars in the yards of all three roads. Three truckloads of merchandise, valued at $1,300, were recovered.

The National Carbon Company, New York, has just moved its emergency brush finishing plant from 237 East Forty-first street to new quarters at 357 West Thirty-sixth street. It is possible in many cases to deliver small orders within half an hour from the time the order is placed, and brushes for larger power units have been completed and ready for use within a few hours. This plant is one of four similar brush stations, the others being located at Pittsburgh, Chicago, and Cincinnati, Ohio.

The General Electric Company reports that, in the year 1924, the company paid to 3,244 employees, $39,531 for suggestions made by the employees which had increased the efficiency of the company's operations. These payments range from one dollar to $1,000. In 1923 a somewhat smaller sum was paid out in the same way. In that year nearly one-quarter of the suggestions offered were accepted and in 1924 more than one-third were accepted.

The Louisville & Nashville has ordered from the Union Switch & Signal Company materials to install Union two-speed continuous automatic train control between Madisonville, Tenn., and Corbin, Ky., 147 miles of lines. The contract includes automatic substation equipments and 26 locomotive equipments. This will be a continuation of the trial installation between Etowah and Madisonville. The construction work will be done by the railroad company's forces.

The Bridgeport Brass Company, Bridgeport, Conn., announces the appointment of Alfred W. Lockwood to its sales organization as special representative operating out of the New York office, handling brass pipe and flush valves. For some years past, Mr. Lockwood has been connected with Cauldwell, Wingate & Co., New York contractors, and his large acquaintanceship and experience in the contracting field will enable him to serve to mutual advantage both the trade at large and his new employers.

W. N. Matthews Corporation, St. Louis, Mo., at the annual meeting of stockholders on March 3, elected the following directors for the ensuing year: W. N. Matthews, Claude L. Matthews, James K. Kearney, M. C. Cooley, and C. C. Fredericks. On March 11, the annual meeting of the Board of Directors was held, at which time the following officers were elected: W. N. Matthews, president; Claude L. Matthews, vice president and trea-

surer; James K. Kearney, vice-president and manager of electrical sales and M. C. Cooley, secretary. C. C. Fredericks, formerly vice-president and general manager of the corporation, left its employ on March 11.

Motor Car for the Boston & Maine

A new motor car and trailer, built by the Sykes Company, St. Louis, and the St. Louis Car Company, St. Louis, Mo., has recently been delivered to the Boston & Maine. It is planned to put this train in operation between North Adams, Mass,. and Troy, N. Y. The motor car is 51 ft. over all, comprising a 16-ft. baggage

Gasoline Motor-Driven Train Built for the Boston & Maine for Main-Line Passenger Service by the Sykes Company, Chicago, and the St. Louis Car Company, St. Louis, Mo.

compartment and accommodations for 30 passengers. It is equipped with a Sterling, six-cylinder heavy duty gasoline engine developing 225 hp. The trailer is of the vestibule type and is 45 ft. 6 in. over all and has a seating capacity of 52 persons, making a total of 82 passengers for the train. This is the third motor car unit to be placed in operation on the Boston & Maine.

Pennsylvania Employees' Savings

The Provident and Loan Association of Pennsylvania Railroad Employees, in its annual report for the first full calendar year of operation shows a membership of 39,663, a gain in 12 months of 24,394. Today approximately one employee in every five on the company's payrolls is participating in the stock-purchasing, savings, increased pension, home-buying, or loan features of the association.

A total of 44,528 shares of the railroad company's stock has been bought for employees through the association, and altogether 11,165 employees are enrolled as purchasers of stock and other securities of the system. The deposits in the savings fund department totaled $5,071,821, a gain during the year of $868,319; number of members holding savings fund accounts, 27,730.

Over 700 members provide for increased pensions upon retirement, through the systematic setting aside of small monthly deposits, and 420 members are purchasing their homes through the association, the amount of building loans authorized for this purpose being $1,322,594.

This provident and loan association was organized in July, 1923. It has the sanction of the company's management, but the company does not guarantee its results financially.

Virginian Electrification Progress

Fifteen miles of the overhead catenary construction has been completed on the section of the Virginian which is to be electrified, and the first boiler in the power plant will be fired within a few weeks. The power plant which is located on the New River at Narrows, Va., will be a pulverized coal burning plant and will be equipped with five, 1521 b.h.p. boilers and four 15,000 kw. turbine generator sets.

The first of the locomotives will probably be delivered about June 1, and the remainder at intervals of about six weeks. They will be delivered as 10 three-unit locomotives and the first locomotives received will be placed in service before all of the overhead work is completed. The western end of the division will be electrically operated first and if present plans can be worked out on schedule, electric trains will be run into Roanoke, Va., the eastern end of the division, by November.

California University to Acquire High Voltage Testing Outfit

So that it can solve the problems of high voltage transmission well in advance of actual requirements, Leland Stanford University of Palo Alto, Calif., has ordered a 2,000,000 volt testing outfit from the General Electric Company. This set will operate at the highest voltage ever produced at commercial frequency, that is, at 60 cycles. This voltage will jump a spark gap formed by two needles spaced about 17 feet apart.

Professor Harris J. Ryan, past president of the American Institute of Electrical Engineers and an authority on high tension phenomena, will in the future devote his entire time to research activities in this high voltage field. The new apparatus will be located in a special laboratory and there will be a large plot of ground for the construction of an experimental transmission line.

New Haven Increases Output at Cos Cob

The complete operation with electric locomotives of the New York, New Haven and Hartford Railroad between New York and New Haven has made necessary the complete electrification of the generating station located at Cos Cob, Conn. With the proposed installation of a new 9,000 kw. turbine and condenser, replacing one of the 3,750 kva. turbo-generators, which will be used in some other part of the power system, complete electrical operation of the Cos Cob station will be realized.

Plans for the proposed installation contemplate the latest special designs and developments in turbines. The contract for the equipment has been awarded to the Westinghouse Electric and Manufacturing Company.

Western Electric Company

The annual report of the Western Electric Company for the year ended December 31, 1924, shows total sales of $298,281,000, as compared with $255,177,000 in 1923. The 1924 sales were the largest in the history of the company. The net earnings for the year available for common stock totaled $8,399,358, equal to 10.7 per cent on the average book value of the no par value common stock during the year which was $157.65 a share. Ten dollars a share was paid on the common or a total of

$5,000,000. The unfilled orders of the company at the close of the year aggregated $92,014,000, as compared with $94,951,000 at the end of 1923 and $62,069,000 at the end of 1922. Of the total sales of $298,281,000 in 1924, $233,300,000 represent sales to the Bell Telephone Companies, $60,707,000 sales to other domestic customers and $4,273,000 to the International Western Electric Company for export.

The income account for the year follows:

Sales	$298,281,138	
Other income	1,212,004	
		$299,493,142
Cost of merchandise	$258,147,923	
Expenses	19,331,724	
Taxes	3,945,099	
		281,424,746
Balance		$18,068,396
Appropriated for		
Additional depreciation on plant	$1,562,539	
Addition to employees' benefit fund	2,000,000	
		3,562,539
Available for interest and dividends		$14,505,857
Interest deductions and bond discount	$4,378,927	
Dividends:		
On preferred stock 7 per cent per annum	1,727,572	
On common stock, $10.00 per share, 500,000 shares	5,000,000	
		11,106,499
Balance carried to common stock		$3,399,358

New Tunnels Through Alps Planned

Several alternate routes for Alpine railway tunnels are being considered, according to the Times (London). Italy and Switzerland are apparently mutually jealous of each other in the matter and are trying to lay out lines wholly within their respective territories. There are two projects, however, for international lines—with one portal in Italy and the other in Switzerland. These are via the Greina and Spluegen passes. The projects vary in cost from $5,000,000 to $60,000,000.

Thirteen Killed in Head-on Collision

Thirteen persons were killed and eleven were injured when westbound Southern Pacific passenger train No. 109 met eastbound passenger train No. 12 in a head-on collision at 3 a. m., March 22, 900 ft. east of the east switch of the passing track at Ricohoc, La., where train No. 12 had orders to head in. Those killed were the engineer and fireman of train No. 109, a baggageman, a newsboy and nine negro passengers. Both engines and two baggage cars were badly damaged and one passenger coach was demolished. The damage to property was estimated at $30,000. The engineman of train No. 12 had an order to wait at Ricohoc until 3:05 a. m. for train No. 109. He failed to observe this order as well as a stop signal from his conductor and a warning from his fireman. He also ran by a block signal which was set against him.

The enginemen who was killed, Edward E. Connery, of New Orleans, La., was about to retire from active service. He had been in railway service since 1878 and had been an engineman for the Southern Pacific for 41 years. His record was unmarred by serious accidents.

Trade Publications

Copperweld Steel Company, New York, has recently issued a set of revised sheets on engineering data and tests pertaining to ground rods manufactured by the company.

Major Equipment Company, Chicago, Ill., has recently issued an illustrated bulletin entitled "Major Flood Lighting Unit," showing a number of applications of this type of lamp.

The General Electric Company, Schenectady, N. Y., in two recently issued bulletins describes and illustrates progress in switchboard equipment. Bulletin No. 47640.2 is devoted to induction, time, over-current relays. The second bulletin is concerned with stationary dead front switchboards with brush contact lever switch.

The Strom Ball Bearing Company, Chicago, Ill., has just published a small 16-page illustrated booklet, describing the Super-Strom ball bearing from the viewpoint of design, dimensions, material, workmanship and load carrying capacities.

The Warner Elevator Manufacturing Company, Cincinnati, Ohio, has recently published an illustrated folder describing the Warner type F 18 dumb-waiter winding engine. Photographs of the equipment as well as diagrams of the apparatus installed are given.

The Martindale Electric Company, 11727 Detroit Ave., Cleveland, Ohio, recently brought out its new catalogue No. 6 entitled Motor Maintenance Equipment. The catalogue is devoted to the illustration and description of commutator slotting and grinding equipment and other motor specialties.

Industrial Controller Company, Milwaukee, Wisconsin, has recently issued two small illustrated bulletins describing automatic starting equipment. Bulletin 7100 C covers equipment which has been on the market for many years, but bulletin 7107 C, describing a new d. c. automatic starter which has some novel features, such as mounting the resistance on the front of the panels. This starter is also built so that it has the same mount dimensions as the class 8527 a. c. automatic starters.

A new 32-page bulletin, bearing the number 47495.1, has been issued by the General Electric Company describing four improved types of oil circuit breakers. The bulletin is illustrated by photographs, tables and diagrams, and details covering construction, operation, characteristics, etc., are fully covered. The circuit breaker types described bear the designations FH-103, FH-203, FH-206 and FH-209, all for controlling and protecting circuits of large capacity. The capacities of these oil circuit breakers vary from 2,000 ampers at 15,000 volts and 500 ampers at 35,000 volts, to 4,000 ampers at 7,500 and 15,000 volts and 800 amperes at 35,000 volts.

New Haven Electrification. A new 48-page publication has been produced jointly by the New York, New Haven & Hartford Railroad and the Westinghouse Electric & Manufacturing Company covering in an interesting manner the entire New Haven Electrification. Chapters 2, 3, 4 and 5 are devoted respectively to a description of the Track and Overhead System, Power Generation and Distribution, the Signal System, and Locomolittle detail regarding equipment, maintenance practice tives and Multiple Unit Cars. Chapter 6 goes into some and shop facilities, while Chapter 7 describes the service rendered by the New Haven and the results which have been achieved by electrification. On a final page is a brief summary of the important facts regarding the electrification.

Railway Electrical Engineer

Volume 16 MAY, 1925 No. 5

Looking Forward

In considering the electrification of steam railways it is of utmost importance that all of the factors entering into such consideration be accorded their true value. There is a strong tendency on the part of both the advocates of steam and electric traction to give more emphasis to some particular feature than to view results as a whole. One of the very much overworked arguments used by those favoring electric traction is the great saving of coal that can be effected by electrification. On the other hand those who take up the steam operating side make the claim that the enormous expense of electrification in power plants, transmission lines, locomotives, etc., can never be justified. Each statement if examined separately appears to be absolutely true, and yet when all of the other factors of electrification are combined with it, the picture may easily be changed to such an extent as to be almost unrecognizable. There are many steam men, who will admit their belief in the ultimate electrification of all railroads, but they usually add that it will not be in their time. On the other hand it is not impossible to find electrical men who believe that certain lines can never be justifiably electrified. There is evidently much more to electrification than the saving of coal, and there is evidence to show that the expense involved, great as it is, is not an unsurmountable barrier.

From the nature of things certain roads will be electrified first. Places where smoke abatement is desired, tunnels, grades, and traffic conditions have been, and will unquestionably continue to be, influencing factors in decisions to electrify. There is, however, another factor which is constantly increasing in importance, and it is one which has not been given undue consideration in the past. It is the growth of the central station industry and the ultimate consummation of the super-power plan. That an enormous amount of electrical energy will be available for railway propulsion purposes in the future is practically assured. Loads of this character are highly desirable for the central stations, and power certainly can be supplied cheaper in large quantities than will ever be possible by individual railways. Moreover, power companies not only supply current, but in the majority of cases furnish the transmission lines and distribution feeders as well. While the railway load on central power stations at present does not constitute a very important factor, there is reason to believe that it may become such in the future, and it is certainly not unthinkable that power companies may work out some scheme of transmission and distribution which will relieve the railways from the installation and maintenance of this extensive overhead construction.

In the future when any road is considering the electrification of some part of its lines, it is more than probable that such planning will include greater territory than has been heretofore the practice. Spotty electrification on any line can scarcely be expected to prove efficient. Where the traffic warrants the electrification of a section of line, there will be a very strong tendency to extend this electrification even further than the immediate business would appear to justify, or at least to design the part installed so that it can be readily added to. It is only by making the electrified section as long as it can practically be made that the full benefit of the electric locomotive or multiple unit equipment can be obtained. The fundamental reasons for electrification do not change, but the introduction of large connected power stations seeking continuous load, together with the fact that such stations may absorb much of the transmission and distribution expense, is bound to prove a powerful influence toward the increase of electric traction in the future.

Underground Wiring in Yards

Wiring in yards for lights or for motors is most commonly run overhead on poles. There is a tendency, however, to do away with poles wherever possible and some conditions make it necessary to run the wires underground. This is particularly desirable in places where a number of outlets must be placed near the ground such as are used for yard battery charging, but, when wires are put underground they must be protected from water, working of the ground, or vibration caused by passing trains and from corrosion by the acid that is always to be found in cinders. Furthermore, the amount of power transmitted is usually not great, the size of the wire is small and excessive cost of such wiring will seldom be tolerated by the management.

The use of parkway cable has been suggested to meet all of these requirements, as the insulated wire is made impervious to water and acid by a lead covering and the lead is protected by a metal armor and a jute covering. The cable is simply dropped into a shallow trench and covered, and when laid, probably costs little if any more than an installation of rubber covered wire in rigid metal conduit. In time it is probable that the acid in the cinders will destroy the metal armor, but unless the cable is dug up again the destruction of the armor will probably not affect the usefulness of the cable. It is highly important that the ends of the cable be protected adequately and care must be taken in the selection of the cable as there are a number of kinds, and experience in this class of railroad yard wiring is limited.

Another suggestion that has been offered is to lay lead covered cable in a shallow trench without conduit, protected by laying pieces of low grade cypress lumber on top of the cable before the trench is filled. The purpose of these boards is to protect the cable until the ground has again settled around it and to prevent possible damage to the cable sheath which might be caused by someone sticking a pick, bar or shovel into the ground. In one instance this kind of underground wiring was used for city street lighting and has been in continuous service without breakdown for 18 years.

Either kind of wiring can probably be used successfully in railroad yards and suggestions or information concerning similar installations already in use will be welcomed by the *Railway Electrical Engineer.*

First Aid for Car Lighting Belts

The problem of car lighting belts is one which apparently will linger for a long time before a final solution is found. Not only is the loss of belts frequently expensive, but the operation of belts during the winter months may be exceedingly vexatious even though the belts themselves are not lost. When ice and snow get on the axle and generator pulleys, it becomes a real job to make the belts perform in anything like a satisfactory manner. During the winter which has just passed, a heavier snowfall than usual was experienced in many of the eastern states with results that belt difficulties were considerably above the average. Slipping belts due to ice coated pulleys became so common on one eastern road that the maintenance forces were driven almost to their wits' end in trying to give light service to the cars. In this difficult situation almost anything was tried to accomplish results and after much experimenting a certain belt dressing compound was found which gave considerable relief; belts which slipped so badly that they would carry almost no load, began to adhere to the pulley faces and the lighting troubles were fewer and further apart.

The application of belt dressing to car lighting belts may be a new idea to some car lighting men, but the success which has attended its use in the instance mentioned, would indicate that it might prove a wise plan to have a little of it on hand for emergency.

Checking the Work of Welders

It is the practice in some shops to have each welder make up a test specimen of his work once a month. This usually consists simply of welding two pieces of boiler plate together. These pieces are marked with the date and the welder's number and are sent to some point to be tested. Testing consists of machining the samples to an exact size or cross section and determining their tensile strength in a testing machine. It may be argued that the performance of so simple a job as welding mild steel under ideal conditions is no test of a welder's skill. It is true that a mediocre welder can usually make such a weld that will show a high tensile strength, but to a trained observer, the skill of the welder is evidenced by the way the metal is applied and the work of the expert will average higher as recorded by the testing machine.

The moral effect of this kind of testing is probably more important than the physical. The fact that the welder knows that his work is to be tested periodically, causes him to keep in mind the importance of doing careful work. Conscientious work on the part of the operator and constant vigilance on the part of the welding supervisor are essential to successful welding. Furthermore, the welder is not the only one who is influenced by the practice of testing the welder's skill. It is extremely difficult for welding inspectors to follow closely the welding practices of any railroad, and they are not prone to be over critical when it is apparent the road is making a conscientious effort to abide by rules and to check constantly that work done by its welding operators.

New Books

Fundamental Principles of Generators and Motors—By Professor F. E. Austin, E. E., 108 pages, illustrations, diagrams and tables, 5½ in. by 8½ in., bound in cloth. Published by the author at Hanover, N. H. Price $2.50.

The book is an example of a great deal of useful information compressed into a relatively small volume. It is a work that is intended obviously for the student and engineer, as the author has used higher mathematics freely to illustrate many of his conclusions. The fundamental principles involved in the generation of an electro-motive force in moving a wire through a magnetic field is clearly brought out by illustrations and text and these principles are logically carried into a discussion on generators and motors. An excellent idea of the subject matter treated may be derived from the following titles: Cutters and loopers, electric motive force of a generator, classification of generators, power efficiency of generators, application of shunt generators, application of calculus, separately excited generators, all-day efficiency of dynamos, motors, work performed by motors, efficiency of motors, electrical versus financial efficiency, operative costs, etc. Throughout the entire book illustrative examples are carefully worked out in such a way that the same principles may be readily applied to similar practical problems when encountered elsewhere.

Transmission Circuits for Telephonic Communications—By K. S. Johnson, 318 pages, diagrams and tables, 6½ by 9¼, bound in cloth. Published by D. Van Nostrand Company, New York. Price $5.00.

The material presented in the book was developed for use in the after-hour courses offered to the members of the Bell Telephone Laboratories. It was originally printed privately for use within the laboratories, but the character of the material and the method of presentation have attracted so much favorable comment and resulted in so many requests for a wider circulation that it is now made available through regular channels of publication and distribution.

The text assumes on the part of the reader a familiarity with the elements of alternating current theory and the operation of differential calculus. The student should also be familiar with the operations of the complex quantity method of presenting alternating current functions. The material presented is intended to cover the general theory and principles which are applicable to the development and design of circuits and lines, and associated with such telephonic instruments as transmitters, receivers, and vacuum tubes.

Chesapeake & Ohio Car Lighting Practice

Low Battery and Generator Maintenance and Few Lamp Renewals Are Obtained by Methods and Equipment Used

WITHIN the last few years car lighting practice on the Chesapeake & Ohio has been brought to a state which warrants the attention of many roads not able to secure similar performance. Batteries are cleaned once in four years, lamp renewals amount to 3.7, 15-watt lamps per car per month and total maintenance costs for 1924 were $21.43 per car per month.

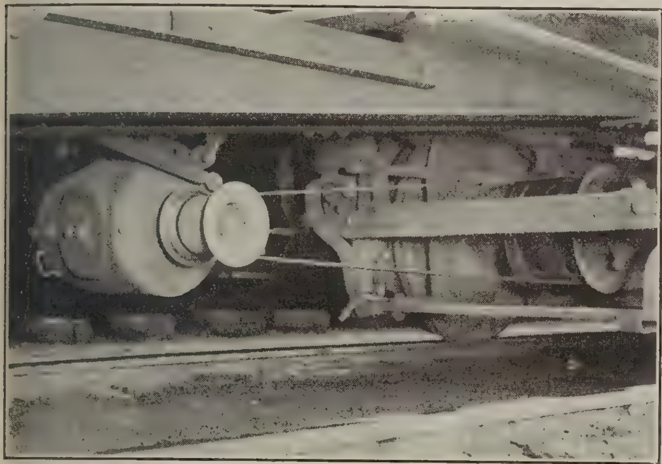


Fig. 1—E. S. B. Body Hung Generator Under Chesapeake & Ohio Passenger Coach

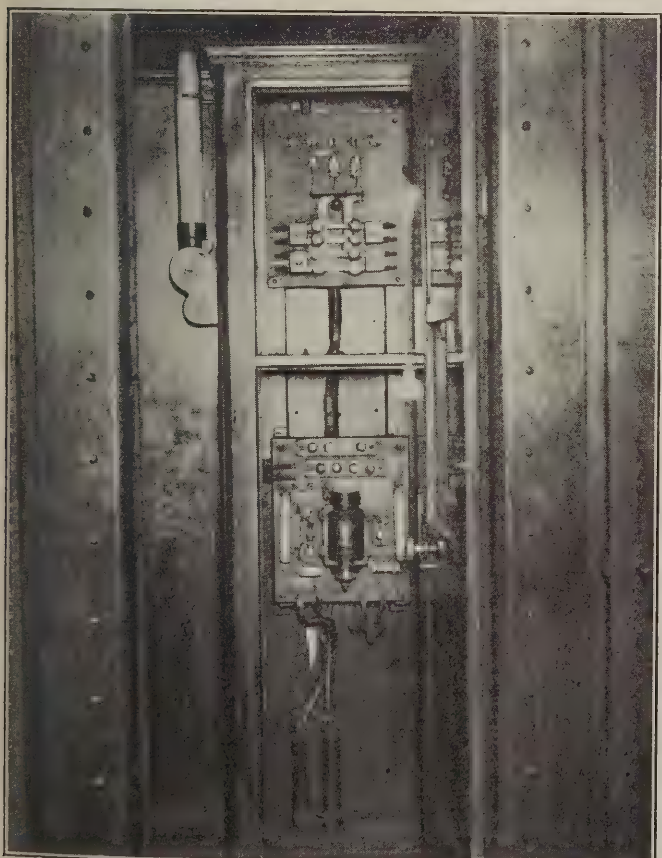


Fig. 2—Regulator Panel Just Inside Car Door

The road has standardized on equipment and all new equipment purchased recently consists of E.S.B. body hung machines with type E.P. 364 amp. hr. Exide batteries having Manchester positive plates, box type negatives and wood separators. Giant rubber jars having 2½ in. of mud space and lead antimony covers are used, two cells being placed in each solid wood tray.

The entire equipment used on this road, however, includes considerable variety. There are 308 axle generator sets operated and 73 cars equipped with straight storage battery lighting. The 308 axle generator equipments are divided as follows: 72 U.S.L. type A; 91 Consolidated type A; 55 U.S.L. Bliss; 29 U.S.L. Moskowitz; 58 E.S.B. type D, 3 kw. U.S.L. regulator panels with ampere hour control are now used with Consolidated equipment. All of the Consolidated and Moskowitz machines have recently been equipped with ball bearings, and ball bearings are now being applied to the U.S.L. Bliss machines.

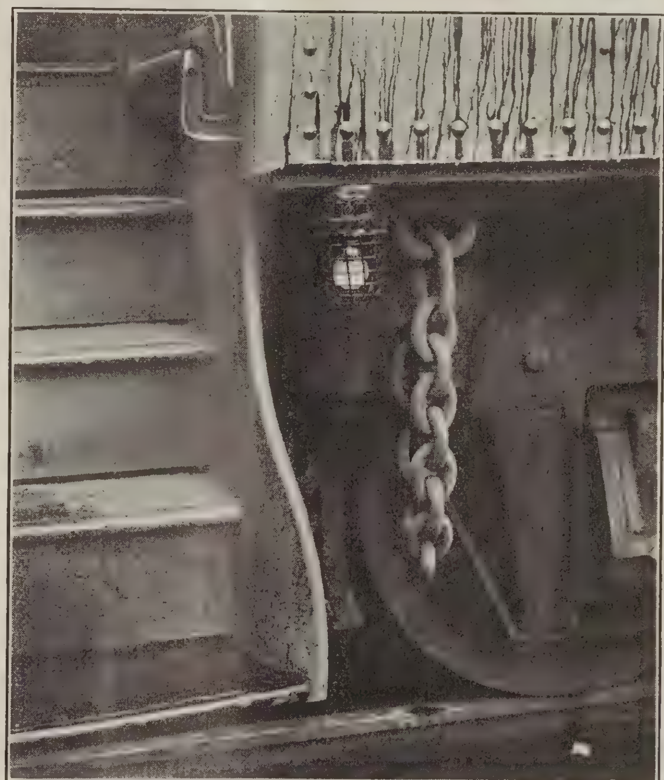


Fig. 3—One of the Step Lights Controlled by Vestibule Door Switch

The batteries used consist of 370 sets of EP 15, 365 ampere hour Exide batteries and 21 sets of 25-cell Edison A6 batteries. The Edison batteries are used on baggage and express cars and the Exide batteries are used on all types of cars. Two sets of batteries are used on business and private cars and these cars are equipped with U.S.L. 100-amp. machines with two-point suspension. Edison batteries are not used with E.S.B. lighting equipment.

Standard C. & O. coach wiring includes 32, 15-watt outlets, not including step lights. Train lines are not

used on old equipment but they have been installed on the new diners and they will be furnished on new coaches when built. The step lights, of which there are four on each car, are a recently added feature of the coach lighting. They are enclosed in heavy wire guards mounted at one side of the step under the body of the car. They are controlled by a door switch so that the lights are turned on when the vestibule door is opened and turned out when it is closed. The step light guards are made to C. & O. specifications.

Fig. 4—Typical Lighting Arrangement of C & O Coach

Fig. 5—Lighting in C & O Parlor Cars Is Similar to That of Coaches

The Chesapeake and Ohio Railway Company

Form L-144
Revised 9. 1923

RECORD OF ELECTRICAL INSPECTION AND REPAIRS

Car.................... Location.................... Date....................

Generator Type.
U. S. L.....................
Cons'l.....................
E. S. B.....................

Check.
Sleeve Bearing.......... ☐
Comb. Ball-Sleeve.......... ☐
Ball Bearing.......... ☐
Truck Suspended.......... ☐
Body Suspended.......... ☐

Panels. Check
U. S. L. C-5.......... ☐
U. S. L. C-6.......... ☐
U. S. L. S-2.......... ☐
U. S. L. A-201-D.......... ☐
U. S. L. C.......... ☐
E. S. B. D.......... ☐
Cons'l A.......... ☐

Equipment Overhauled Date.................... At.................... Next Due....................
Ball Bearings Greased Date.................... At.................... Next Due....................

Date	Place	Train No.		Class Insp.	Ampere Hour Meter	Voltage		Lamps Applied		Belt Applied		Batt. Flushed	Electrician Repairman
		Ar.	Dept.			Lts.	Batts.	No	Watts	Wdth	Lgth.		
1													
2													
27													
28													
29													
30													
31													

Note.—"T"—Temporary inspection and repairs. "P"—Permanent inspection and repairs. "C.O.—General overhauling. "Each repairman to record his individual work and inspection." This card to be removed and forwarded to Chief Electrician from first terminal reached after last day of month and new card inserted

Fig. 6—Front of Inspection and Repair Card Which Is Kept in Regulator Locker

Of the 58 E.S.B. equipments which are now standard for the road, one has been in service 12 years, 26 have been in service 2 years. Ten of these equipments are used on diners, 6 on mail and baggage cars, 34 on passenger cars and 8 on combination baggage and passenger cars. This equipment was adopted because of its dependability and the low maintenance cost of both equipment and batteries. During the entire time of service supplied by

RECORD OF OVERHAULING

Date.................................At.........................
Generator..
Suspension...
Gen. Reg...
Lamp. Reg..
Ampere Hour Meter..
Fans...
By................................ (Name)

BATTERY

Last Cleaned......................................Date New..............
Type..No...............
Dates Flushed..

LEAD BATTERIES

Individual Cell Voltage Readings with Full Load.

Volts	Volts	Volts	Volts	Volts	Volts	Volts	Volts

Volts	Volts	Volt	Volts Sp. Gr.	Volts	Volts	Volts	Volts Sp. Gr

EDISON BATTERIES

Volts	Volts	Volts	Volts	Volts	Volts	Volts	Volts	

Volts	Volts	Volts	Volts	Volts	Volts	Volts	Volts	Volts

Volts	Volts	Volts	Volts Sp. Gr.	Volts	Volts	Volts	Volts Sp. Gr.	

Remarks:...
....
By................................ (Name).

Fig. 7—Back of Inspection and Repair Card

the 58 equipments only one armature and one set of field coils have been replaced. The life of batteries with this equipment is about eight years and since the Giant rubber jars have been installed, it is apparent that the batteries need only be cleaned once in four years. Batteries practically never require flushing oftener than once in two months. The only trouble experienced which was caused by a fault of the equipment was caused by ballast lamps used in the bridge resistance burning out. This, however, has been corrected by the manufacturers. Eighty-five per cent of all main line equipment is now E.S.B. while the other 15 per cent and all branch line service is handled with other types of equipment. Baggage and mail cars and express cars are fitted with U.S.L., 1 kw. type A, form 201 D equipment with ampere-hour meter control.

Out of the total of 308 machines 176 are truck mounted and 132 are body hung. The body hung equipment includes all E.S.B. and all U.S.L. 1 kw. machines.

The center line of the belt on most of the body hung machines is within a few inches of the center line of the car. In the few cases where the brake rigging did not permit this, the generator has been set back about a foot toward the center of the car and the belt made about two feet longer. Pressed steel axle pulleys having a 10-in. face and a beveled flange, with corrugated axle bushings are used. E.S.B. equipment is fitted with 17-in. dia. axle pulleys and 6-in. armature pulley, while the 1 kw. U.S.L. machines have a 17-in. axle pulley and a 5-in. armature pulley.

During 1924 an average of 4 belts per car per year were used, giving a mileage of about 30,000 miles per belt. Considerable difficulty was had, however, with some belting which was purchased on specifications, and experiments are now being conducted with five different makes of belt in an effort to improve conditions and increase belt mileage.

The yard charging which is necessary is done at C. & O. yards, Covington, Ky., and at Washington, D. C., by the Washington Terminal Company. The C. & O. also has

Form L. 272
Pad 100 Sheets

THE CHESAPEAKE AND OHIO RAILWAY COMPANY

STANDARD BATTERY MAINTENANCE REPORT

.............................Location [illegible] ....

Removed From Car No.................. Why Removed ....
Battery No.................. Mfg. Name ....
Serial No.................. Capacity..........................AH
Date New.......................Positive Renewed.................... Terminal
Date Previous Cleaned ....Number [illegible]
Date Cleaned on this Removal .... Terminal

RECORD OF REPAIR PARTS USED

Crates—12100 12105 ....Giant [illegible] ......
Covers—6415 11519.................................Separators 11602 ......
Pos. Groups—8170...................................Neg. Groups—8100...........
Hd Rubber End Linings—3472.........................Hd Rubber Side Linings—3102...........
Wood End Shims—12114...............................Wood Side Shims—12116...............
Vent Cap—3026 .... Terminal [illegible] 5416 ......
16½ Cable Connectors—8238 .... 50" [illegible] 5234 ......
REMARKS: ....
....

EDISON BATTERIES.

Solution Renewed: Date.................................. Terminal.....................
State Parts Used ....
....
Applied to Car No .... Date ....

Fig. 8—Battery Maintenance Repair Sheet Which Is Filled Out When Battery Is Cleaned and Repaired. The Actual Size of This Form is 8½ In. by 11 In.

charging plants at Huntington, Richmond and some of the smaller points but it is only necessary to use this equipment on straight storage cars operating in the territory. Besides the straight storage cars the charging facilities are used for mail cars and cars in one train which has a run including two nights.

Under normal conditions where the battery is not so

run down that an excessive charging rate is required, voltage regulation is kept within two volts with the E.S.B. equipment and the specific gravity of the batteries does not get very far away from 1,175 to 1,190. If the nature of the run is such that a higher rate of charging is required, the regulator pin is taken out until the battery is once more up to full charge. Battery switches are pinned in with a cotter pin when the car leaves the yard.

Both equipment and batteries are inspected once a month and a record of the inspection is placed on an 8-in. by 11-in. card which is kept in the regulator locker in the car. The front of this card, which bears the number of the car, is shown in Fig. 6. Half of the back of the card is shown in Fig. 7. The other half of the back of the card is left as a space for remarks of the inspector. At the regular inspection periods all necessary repairs are made, batteries are flushed if flushing is required and ampere-hour meters are adjusted if necessary. Whenever a new belt is applied, this fact is noted on the card and a notice is sent to the main office. Amount of sediment in batteries is measured with probe sticks.

One other record, Fig. 8, is kept which consists of a sheet made out when the battery is overhauled. One of these records, which is simply a sheet of paper 8½ by 11 in., is made out and sent in to the office each time the battery is cleaned or moved from one car to another. These sheets are filed under the number of the battery.

Maintenance work is done at Covington, Ky., Richmond, Va., and Huntington, W. Va., but no battery work is done at Covington. The maintenance force consists of 19 electricians and 7 helpers.

Northern Pacific Lighting Specifications Save Money

By issuing lighting specifications and putting them into practice by a process of education and enforcement, the Northern Pacific has cut its annual bill for lamp renewals a considerable amount.

The method used is extremely simple. First a general specification was prepared listing all of the various types of lamps carried in stock and describing how they should be ordered and how they should be used. Then a schedule was prepared for each terminal or location on the railroad where lamps are used. These schedules specify the type, size and voltage rating for the lamp in each lighting outlet. To prepare these schedules meant that a competent man had to go over the entire system, check up all lighting outlets and decide what kind of lamp should be used in each outlet. This work required the services of one man for about three months. The savings effected, however, amply justified the effort.

The first part of the specifications as issued read as follows:

"Specification No. 40-D for Ordering Electric Light Bulbs.

"This specification supersedes all previous specifications for ordering electric lamp bulbs.

"Hereafter, in making requisitions for incandescent lamp bulbs, please specify the lamps desired in accordance with the following tables, giving the watts, voltage of circuit upon which they are to be used, and type of bulb and base.

"When lamps are used on circuits of slightly higher voltage than the rated voltage of the lamps, the ilfe is materially reduced. The voltage regulation of circuits is not perfect, generally at certain times the voltage is higher than normal, therefore, lamps of the standard voltage higher than the normal voltage of circuit should be specified. Example: If the voltage of the circuit is known to be 117, then the proper lamps to use are 120 volts.

"General Storekeeper will see that requisitions placed with the Purchasing Department will be for standard package quantities, or multiples thereof whenever possible. It is allowable, however, to combine in one standard package all sizes of lamps having the same standard package quantity."

Following the opening paragraphs quoted above, the specification sheet lists all of the lamps carried in stock by the railroad with the standard package quantity.

For general lighting purposes this includes various sized lamps with voltage ratings of 110, 115, 120, 125, 220, 230, 240 and 250 volts. Train lighting lamps are all 64-volt lamps; 34-volt lamps are used for locomotive headlights, 33-volt lamps for cab lights, and lamps of special rating are listed for special purposes such as for electric lighted switches, highway crossing protection, etc.

Quotations from a typical schedule sheet are as follows:

Schedule of Electric Lamps for All Facilities at Missoula, Montana.

"New Storehouse"

5—25-watt, 240-volt Mazda B lamps—1st floor aisle
3—100-watt, 240-volt Mazda C lamps—outside brackets
23—50-watt, 240-volt mill type lamps—vault and basement

. . . .

. . . .

"Machine Shop"

30—100-watt, 240-volt Mazda C lamps—ceiling machine bay
3—100-watt, 240-volt Mazda C lamps—brackets machine bay

. . . .

. . . .

"New Coal Dock"

2—50-watt, 240-volt mill type lamps—motor room
9—100 watt, 240-volt Mazda C lamps—coaling tracks

. . . .

. . . .

Copies of the specifications are issued to storekeepers, superintendents, master mechanics and to all men on the system interested in lamp renewals. Copies of the schedule for a given point on the railroad are given to the local electrician and to others at that point who need this information. The local electrician checks all lighting outlets with the schedule and provides each outlet with the proper lamp.

The management of the railroad has endorsed the schedules and the specification sheet and compliance with them is enforced. Outlets at different points are checked up at various times and if they are not properly lamped an explanation is demanded.

The saving in lamp renewals which has been effected by the use of this method is due largely to using lamps having the correct voltage rating for the circuit voltage at that point. Having the right kind of lamp is also important. If a mill type lamp is needed, another type is not sufficiently rugged and will be short lived; if too large a lamp is used, the cost of this lamp is unnecessarily high and the lighting is probably made worse instead of better.

A saving in power consumed has also been effected by preventing the use of unnecessarily large lamps which some employees are prone to use if not prevented from doing so.

The electrical export trade is enjoying a satisfactory trend and the figures show every indication of being well above those of last year, according to the electrical division of the Department of Commerce.

Two Electric Locomotives Coupled Together for Multiple Operation

Electric Locomotives for the South African Railway

Operation at 3,000-Volts d. c. Introduces Many Unique Features in Design of Equipment

ONE of the latest developments in main line railway electrification is that of the Glencoe to Pietermaritzburg section of the South African Railway—a section which handles heavy mineral traffic down to the coast. The track has a route mileage of 171 miles, traversing very hilly country with long and difficult grades. It reaches an altitude of 5,000 ft. above sea level and runs down to the 2,200 ft. level at Pietermaritzburg, 1,350 ft. in a distance of 14½ miles.

The overhead contact wire system is used at 3,000 volts d. c. with the standard track return. The power is converted at substations along the line, which are supplied by a three-phase overhead transmission system at 88,000 volts, 50 cycles.

In connection with this scheme the Metropolitan-Vickers Electrical Co., Ltd., are supplying seventy-eight combined passenger and freight locomotives.

In view of the limitations of the track, such as the gage, a minimum radius of curve of 300 ft. load per axle, etc., and the very heavy trains that have to be dealt with, a single locomotive unit is unsuitable. Consequently, three locomotives are coupled together, driven in multiple, and controlled from one driver's cab. In normal working three locomotives haul a freight train of 1,430 short tons to Pietermaritzburg, and on the return journey, one of 700 short tons. Wherever control of speed on a down grade is necessary, this is done by the regenerative action of the locomotive alone.

Leading Dimensions of a Locomotive

Weight in working order	133,200 lb.
Weight of mechanical portion	78,800 lb.
Weight of electrical portion	54,400 lb.
Type of locomotive	A.A. + A.A.
Gage	3 ft. 6 in.
Motor equipment	Four 300 hp. motors
Total motor rating	1,200 hp. one hour rating
Tractive effort, full field	21,200 lb. one hour rating
Tractive effort, maximum	40,000 lb.
Tractive effort, full field	16,400 lb. continuous
Speed, full field	21.5 m.p.h. one hour
Speed, full field	23 m.p.h. continuous
Maximum safe speed	45 m.p.h.
Traction system	3,000 volts d.c.
Brakes	Compressed air operated
Over-all length	43 ft. 8 in.
Overall height of body (pantagraph down)	12 ft. 11.3 in.
Overall width of body	9 ft. 2.25 in.
Dia. of driving wheel	4 ft. 0 in.
Fixed wheel-base	9 ft. 3 in.
Total wheel-base	30 ft. 11 in.
Distance between truck centers	21 ft. 8 in.
Weight per driving axle	33,300 lb.

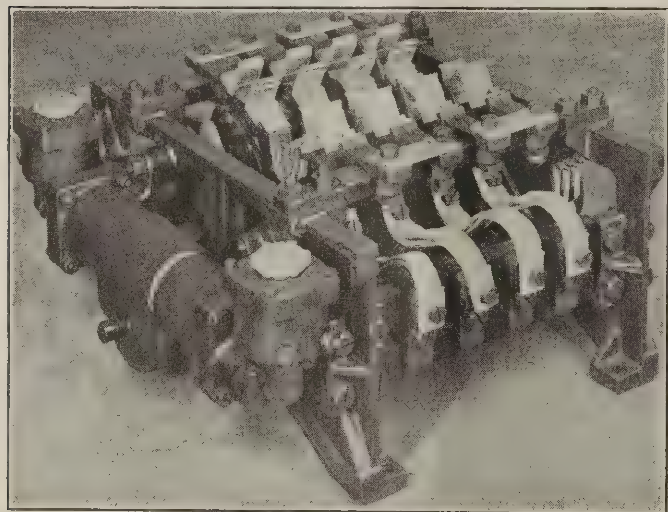
Mechanical Features

The body of the locomotive containing the electrical equipment and auxiliary gear is supported by two four-wheel trucks coupled together at their inner ends by an articulating joint, which allows free movement between the trucks. The buffing and draw gear which is of the central type is mounted directly on the trucks. The truck center pivots are in three castings. The top, which is in steel, is rigidly bolted to the underframe and has a spherical seating which rests in a phosphor-bronze rubbing plate. The latter is held by a steel casting bolted to the center stay plates. On one truck the rubbing plate is held firmly in the casting while on the other it is free to move longitudinally. This feature is introduced to compensate for the varying positions of the trucks on curves. The body is relieved of all draw and buffing shocks since these are transmitted directly through the truck frames and the articulating joint. Steadying of the body and the trucks is carried out by side and end bearers, which are spring-loaded.

The trucks are of the frame plate construction arranged with top and bottom stay plates at the ends and center. The transom, besides supporting the truck center casting, also carries the motor nose suspension brackets. The bearing springs are of the laminated type with adjustable links

and are placed above each axle-box. Compensation is provided for by beams pivoted on knife edges, which are attached to the centers of the truck frame plates.

The body of the locomotive is divided into five compartments. There is a driver's cab at each end containing all the necessary control gear, meters, gages, brake valves, etc., with which to control the locomotives. In the center is situated the high tension compartment containing all the high voltage control gear, access from the gangway is obtained by a sliding door which is both mechanically and electrically interlocked to prevent it being opened while the pantagraph is up. The spaces between the high tension compartment and the cabs at each end are occupied by the auxiliary gear, which includes two motor generator sets, each coupled to a blower, a compressor, exhauster, reservoirs containing air for the brakes, low tension control gear and pantagraphs, low tension switches, and contractors for controlling the auxiliary gear. The sections of the roof above these compartments, and the roof above the high tension com-



Cam Operated Switch Group

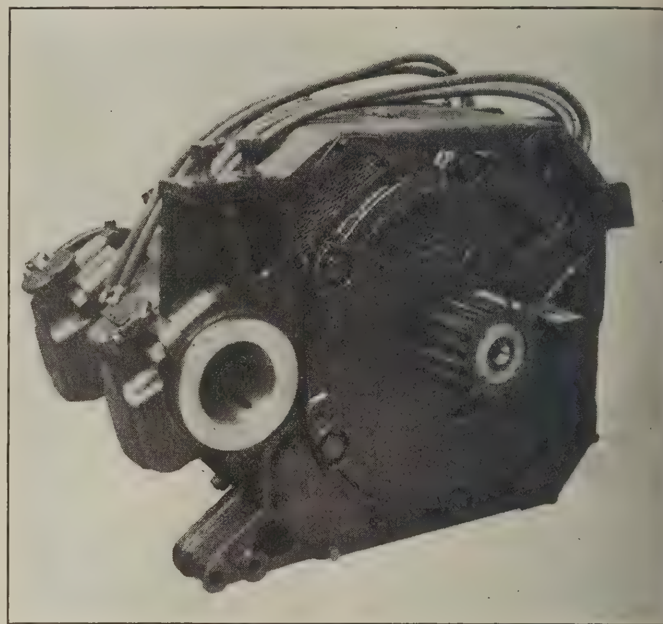
partment are easily removed to lift out the heavy machinery and control gear.

The vacuum brake system is used on all the rolling stock, the locomotive brakes, however, are operated by compressed air, this system being found to be more suitable under the circumstances. By means of a vacuum operated air valve application of the vacuum brakes will produce a proportional braking effect on the locomotive. For shunting purposes the driver has a compressed air brake valve which only applies the locomotive brakes. Air connection between locomotives is arranged in the main reservoir circuit to supply air to another locomotive in the event of failure of its compressor.

Sanding is arranged for multiple control, the sander valves are electrically operated and their control wire is included in the train line cable, thus all locomotives when coupled in multiple, sand simultaneously.

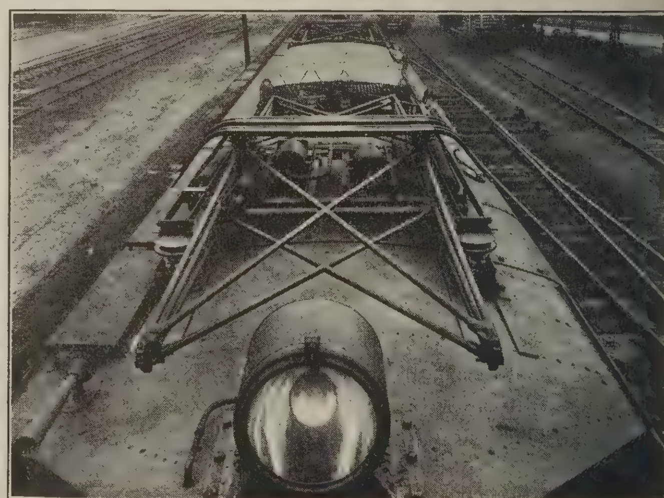
Main Motors

The main motors, four in number, are of the series wound type and are arranged for operation with two connected permanently in series, thus having 1,500 volts per commutator. The motors have been designed to give the maximum output that can be obtained in the limited space, and although working on 3,000 volts they are rated at 300 hp. with full field on the one hour test basis, corresponding to a speed of 21.5 m.p.h. with a gear ratio of 17/75 and 48 in. diameter wheels. The magnet frame is cast in one piece and is practically octagonal in shape. The suspension of the motor is carried out by means of the



One of the Main Motors—Pinion End

usual axle bearings and from a nose on the other side of the motor, which is supported on rubber springs held in the suspension bracket on the bogie transom. The motor is a four-pole machine with interpoles; a tapping is made on the main field to give reduction in excitation



Roof Construction Showing Pantagraphs and Type of Headlight Used

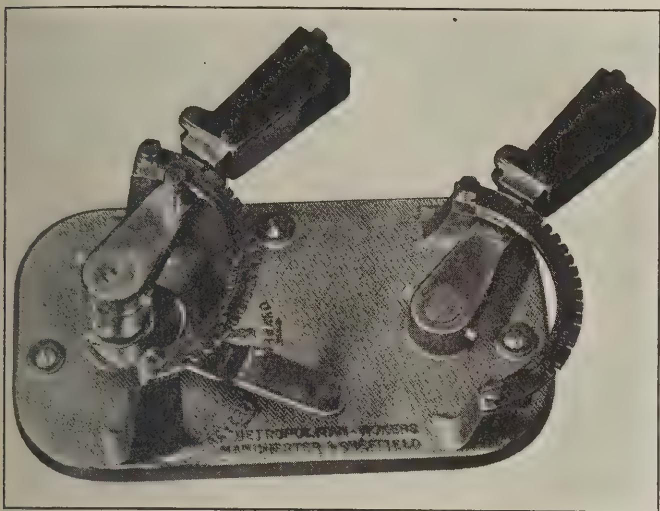
for running on weak field. Inspection covers are arranged above and below the motors at the commutator end to give accessibility to the brushes, which can be easily inspected when the motor is in position.

The motor is arranged for forced ventilation. Air enters the motor at the commutator end through a flexible air duct leading from the blowers, and flows in parallel

paths through the machine, leaving by means of openings at the pinion end.

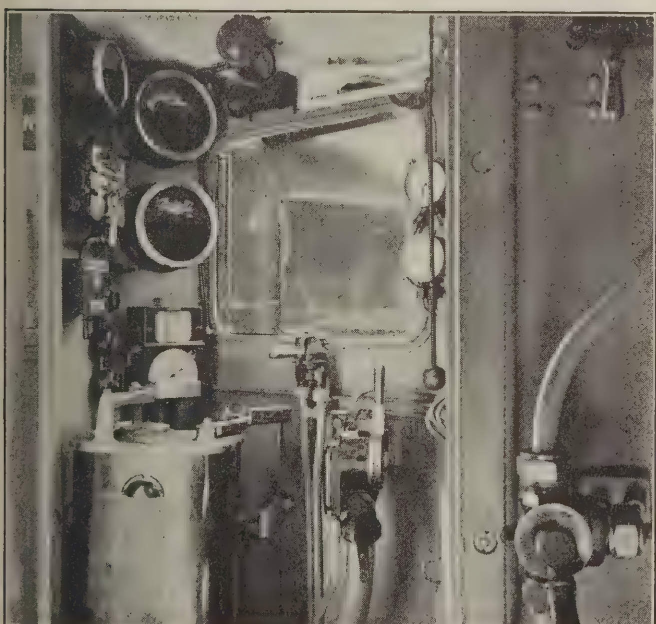
Control Gear

Each locomotive has two pantagraph current collectors which are pneumatically operated. Spring control en-



Top View of the Master Controller

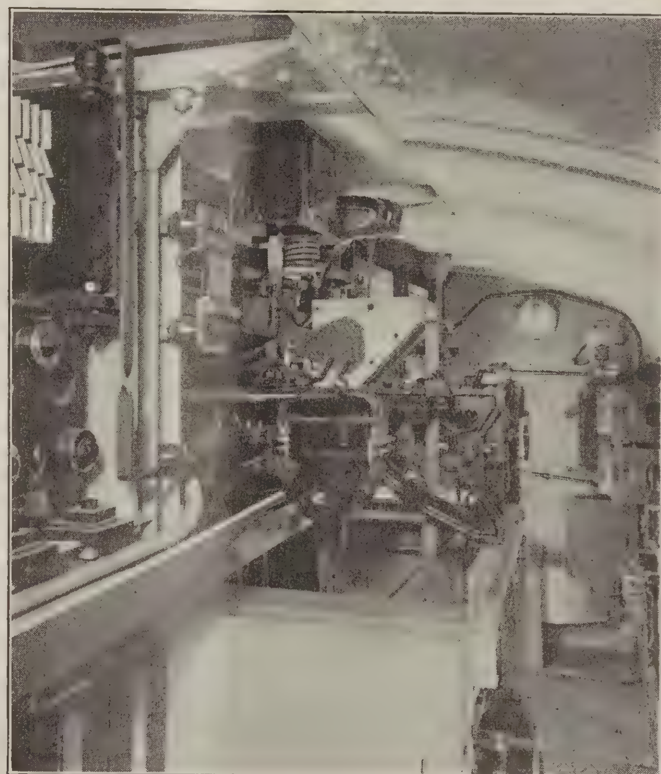
sures that a uniform contact pressure is maintained with varying heights of the trolley wire. The whole pantagraph framework is carried on four insulators which are supported on the roof by heavy brackets. Air is fed to the pantagraph cylinders through an electrically operated valve which is controlled by a two way switch in the



Interior of Drivers' Cab Showing Controls and Indicating Meters

driver's cab. The pantagraph control wires run through the train line cable hence the driver has complete control over all pantagraphs from one cab. Each pantagraph is capable of collecting the current for all the motors, therefore it is only necessary to have one up at a time, the other being used as a stand-by.

Current is led through to the main equipment by way of the main isolating switch which is situated in the high tension compartment. The compartment door is interlocked with this switch, and the pantagraph air circuit, in such a manner that it is impossible to enter the compartment when the equipment is alive. The isolating switch is connected through a trolley overload trip to the control equipment. The line and resistance switches are pneumatically operated and have a contact pressure on normal working of 140 lb. To ensure a high speed of break the piston closes against a heavy spring. All the parts of the switch which carry the main current are insulated for a working pressure of 3,000 volts to ground. These switches are arranged in two groups of ten and eleven respectively, along the longitudinal center line of the locomotive. In the center of the compartment



High Tension Chamber Showing Cam Group in Position

are the cam operated switch groups. These switches are operated by a double ended piston carrying a rack which engages on a pinion fixed to the end of the camshaft. Both types of switches are characterized by their reliability of operation, ruggedness and accessibility for inspection. The cam groups are used for the motor combination, forward and reverse, motoring and regenerating, and the weak field connections.

In every possible case, the switch to switch, and switch to resistance connections are made with bare copper rod or strap, thus occupying the minimum space, and eliminating fire dangers. The high tension cables are enclosed in steel conduits affording sound mechanical and fire protection.

Arranged above the unit switches are the resistance frames. They are of the cast grid three point suspension type and the pressed steel type, the latter being used for the stabilizing resistances and the earlier steps of the accelerating resistance. The grids are carried by three

insulated bars which are held by insulators in the end frames, and a further factor of safety is introduced by insulating these frames from the supporting beams.

The control wiring is carried in special wire ways which run behind the switches.

The high tension compartment also contains electro-magnetic contactors for starting up the motor generator sets, the auxiliary fuse groups, which are of the expulsion type and are graded in steps with suitable resistances, motor overload and over-voltage relays which operate an auxiliary relay connected in the control circuit of the resistance switches, stabilizing resistances and switches, and all other high voltage gear.

The master controllers which are situated in the drivers' cabs have three independent drums on one central spindle. These drums are used for the motor combinations, series and parallel in forward, and series in reverse, acceleration, and regeneration respectively. Complete mechanical interlocking is adopted, no blow-out coils are required since the currents used for energizing the magnet valves are extremely low and the control is on a 100 volt circuit. All wires from the master controller connect to a terminal board at the back of each cab, the boards are connected together by two train line cables and are each connected to four jumper receptacles which are carried to the ends of the locomotive on the underframes. The control equipment can be completely isolated by a multi-point cut-out switch which is connected between the main terminal boards and the control equipment. Defective motors are cut out by motor cut-out switches connected in the control circuit.

Complete lighting is installed and is supplied from the 100 volt circuit which is fed by a 16 kw. generator in parallel with a 100 volt battery. The latter is carried on the outside of the locomotive in two boxes suspended from the underframe between the bogies. The locomotive carries a high powered headlight at each end.

Auxiliary Gear

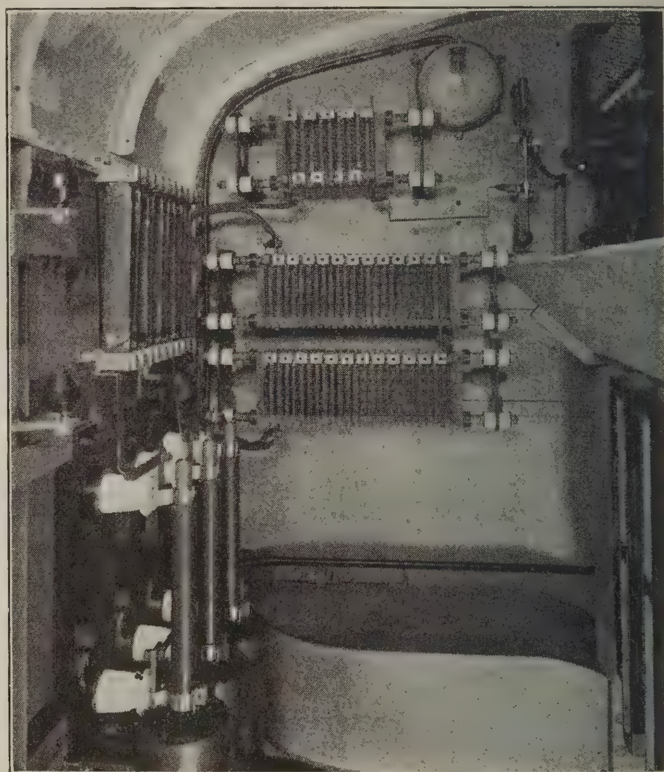
There are two motor generators of 16 kw. and 28 kw. capacity respectively. The motors of both are similar, in having two distinct windings connected to a commutator at each end of the armature, the two commutators are connected in series externally and the motor fields are in series on the low tension side of the armatures and also with the series fields of the generators.

The 28 kw. set is used for exciting the fields of the main motors when in regeneration. The motor and generator are mounted on a common shaft to the end of which is fitted a blower fan supplying air to two of the main motors. The motor has a shunt holding winding connected across the low tension supply while the generator has a shunt winding in series with a regulating resistance which is cut out step by step by electro-magnetic contactors actuated by the regeneration drum on the master controller, the winding being connected directly across the low tension generator.

The 16 kw. set is used for supplying the control circuits, lights, exhauster, compressor, exciting the larger generator, cab heaters, and maintaining the battery on charge through an automatic battery cut-out switch. On this machine the motor and generator frames are separate but stand on the same bedplate. A fan is connected to the end of the motor shift supplying the remaining two main motors with forced ventilation.

The two motor generators are connected in series with starting resistances connected through a double break contactor to the 3,000-volt auxiliary fuses and thence to the main isolating switch. The starting resistances are short circuited by a contactor operated by a current relay set to close when the motor current falls to a fixed value. It is possible to cut out the larger set but in this case interlocking is so arranged as to prevent regeneration. Normally both sets are always running.

The compressor is of the horizontal two cylinder type driven through gearing by an 8 hp. series wound motor. The set is switched into circuit through a starting resistance, to prevent series fluctuations, by a contactor operated through a time lag relay. Simultaneous control of all compressors when in multiple is obtained by a synchronizing wire connecting up the compressor governors which are connected in the control circuit. The compressors supply air to the brakes, sanders, horns, control gear and pantagraphs.



Interior of Locomotive Showing the Auxiliary Fuse Group

The exhauster is of the rotary drum type direct coupled to a series wound motor with tapped field. The motor is rated at 4 hp. at 1400 r.p.m. and at high speed 6 hp. An electro-magnetic contactor operates the tap field and is in turn actuated by a switch which is closed when the vacuum brake is in release.

Both the compressor and exhauster motors are connected across the low tension supply and are switched into circuit through double pole switch fuses.

Operation

The control is arranged for series and parallel in a forward direction series in reverse and series or parallel in regeneration.

The positive feeds to all switches and to the exhauster control circuit and sanders pass through the combination

drum of the master controller which is operated by the driver's control key. This feature ensures that one man only has complete control of the locomotives when in multiple. On the first notch series three line switches close, and connections are made for motoring with the four motors in series and all resistance in. The control interlocking is so arranged that the cam groups must throw to their correct positions before the unit switches close thus preventing the possibility of the cam switches breaking any current.

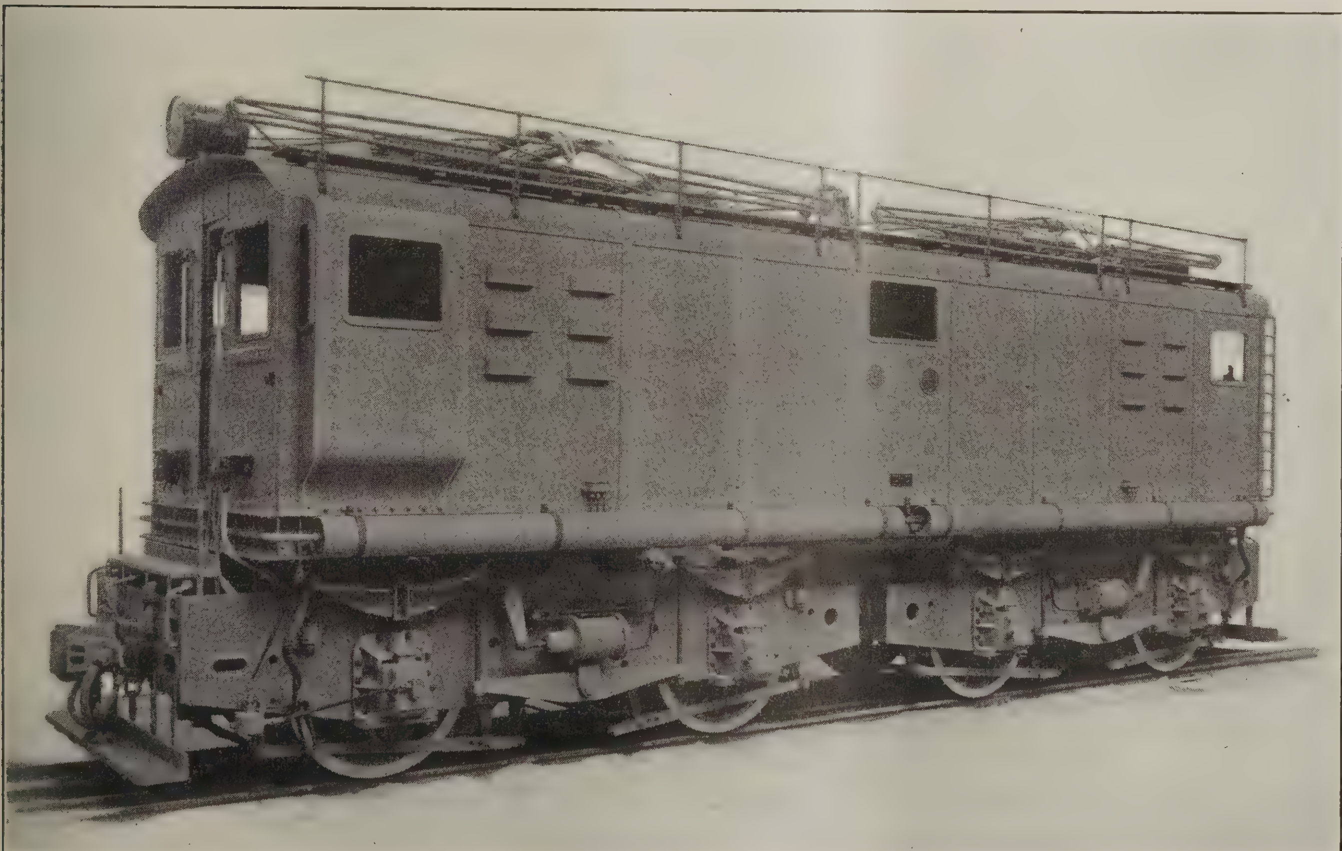
The resistance is cut out step by step by moving the accelerating handle to the consecutive notching points on the acceleration sector. This accelerating handle is arranged with a detent and lever, a slight pressure on the lever withdraws the detent from the slot in the notching plate. Upon releasing the lever the detent automatically engages on the next tooth. The slightest pull on the handle moves it forward until the detent automatically engages in the next slot. This feature greatly facilitates an accurate notch to notch movement of the handle without necessitating any great amount of care on the part of the driver.

The control circuit is interlocked to prevent starting in motoring with parallel connections. To take transition the combination handle is moved to the parallel position, no change of connections taking place. All resistance is inserted by moving the accelerating handle to the first notch, the cam group then commences to throw to parallel, it short circuits two motors and its travel is arrested until the short circuit is opened by a unit switch, then it completes its travel and the parallel switches close. The resistance is cut out step by step as before and weak field operation can be had if desired. In the event of an overload, the trips immediately insert two banks of resistance, the resistance switches drop out and insert the remainder of the resistance after which the line switches break the circuit. To reset, the accelerating handle is moved to the "off" position, thus opening the remaining unit switches and the combination drum has to be moved to its series position before notching can again take place.

In regeneration all the four main motors are used as generators with separate excitation. For this purpose the 28 kw. motor generator is used. The generator maintains constant voltage with variation of load and its excitation varies in proportion to the line of voltage, the latter feature is obtained from the 18 kw. generator. By means of the contactors connected to the field regulating resistance of the 28 kw. generator, thirteen different steps of voltage are obtained under the control of the regeneration handle on the master controller.

The driver is able to come into regeneration either with his motors connected in series or in parallel, the former over the lower ranges and the latter for the higher ranges of speed. When regenerating, all resistance is inserted in the motor circuit and the regenerating connections are made with the fields under minimum excitation. The driver then cuts out his main resistance and brings up his excitation until the train is held at a steady speed on the down grade.

To prevent the motors generating current at excessive voltage, they are protected by an over-voltage relay which trips the circuit above a certain voltage.



One of Four 100-Ton, 2400-Volt, Direct Current Electric Locomotives Built by the English Electric Company, Ltd., for the Montreal Harbor Commissioners. The Mechanical Parts Were Built by Beyer Peacock & Company, Ltd., England

Testing Stand for Car Lighting Equipment

To give car lighting equipment a thorough test, it is necessary to have some means of driving the generator at various speeds as it is driven on the road and at the same time have it in a position where its operation can be watched. This can be done by leaving it in position under the car and driving it with a motor placed under the car, or it can be done by means of a testing stand such as the one shown in the illustrations. To drive the generator in position is the simpler operation, but power for driving the motor is not often available in the yard and if the equipment is in need of overhauling, it is desirable to take it into the shop.

The testing stand shown was built in the Chesapeake & Ohio shops at Richmond, Va. The driving motor, which is the left-hand machine in Fig. 1, is a discarded 64-volt U. S. L. car lighting generator mounted on slides so that the belt can be easily lined up and tightened. By moving the brushes from one position to the other, the machine can be driven in either direction.

Power for driving the motor is taken from the 80-volt welding circuit in the shop. This power is brought into the left-hand box on the left-hand board, Fig. 1. This box contains a two-pole fuse cut-out and a two-pole knife switch. The right-hand box contains a General Electric starter controller. Moving the handle from the position shown to a vertical position starts the motor by gradually cutting out resistance in the armature circuit. When the handle is all the way up a pawl drops into place which releases the armature resistance from the control arm and connects the arm to a field resistance. Then as the arm is moved back, resistance is cut into the motor field circuit so that the motor can be run at any desired speed.

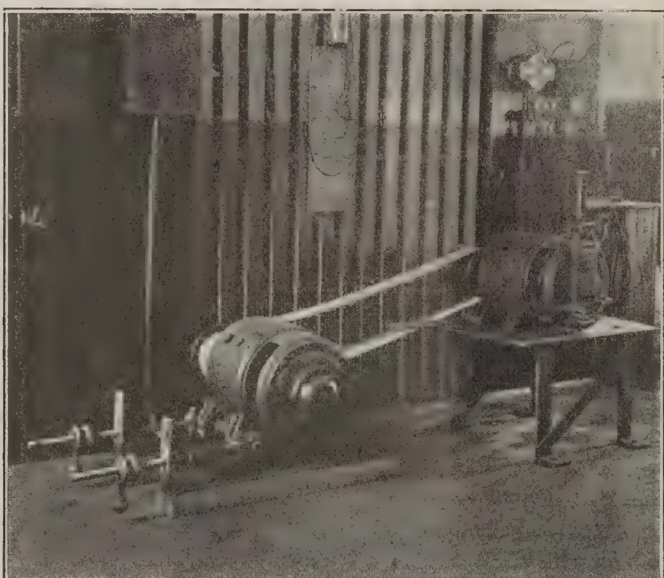


Fig. 1—Generator Testing Stand Showing Motor, Generator and Panel Testing Boards

The generator to be tested is bolted to the stand or table shown at the right, Fig. 1, where it is readily accessible. This stand is made of a piece of 3/8-in. boiler plate, 24 in. wide and 30 in. long, mounted 18 in. above the floor on 1/2-in. by 3-in. flat iron legs bent and braced as shown.

The regulator panel to be tested is mounted on the board shown at the right in Fig. 1 and also in Fig. 2. This board is equipped with flat iron brackets which will accommodate any kind of regulator panel and will hold it out about 6 in. in front of the board.

The generator and panel are connected just as they are on the car and a pair of leads from a battery in another part of the shop is brought to the panel through the conduit which ends close to the lower right-hand corner of the panel, Fig. 2. The lamps shown at the top of the board are controlled by the snap switch at the right and are connected in the same manner as the lamps in the car. These lamps provide practically full load as the first lamp is a 100-watt unit; the second, a 250-watt, and the other two, 50-watt units.

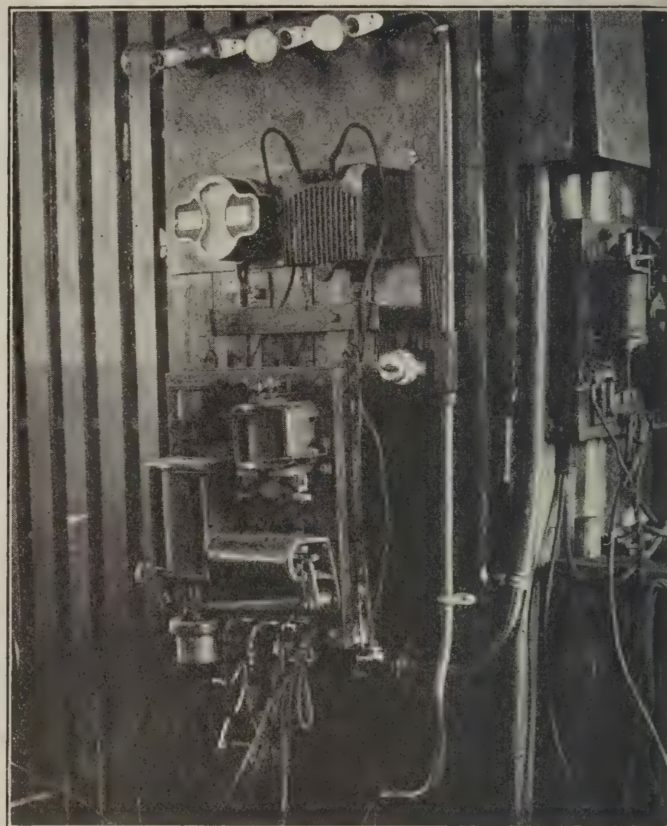


Fig. 2—The Panel Testing Board

The meter mounted on the board is a combination volt and ammeter, the voltmeter being in one side of the case and the ammeter in the other. The voltmeter is connected directly to the generator while the ammeter is connected to an ammeter shunt mounted on the board below the panel behind the connecting leads. A dummy fuse is put in place of the generator fuse and leads from each end of this fuse are connected to the ammeter shunt. The rheostat mounted at the right of the meter is used for testing Moskowitz equipment.

To test the equipment it is only necessary to bring the speed up gradually from zero to maximum speed, watch the voltage at which the automatic switch closes and watch the amount of current generated by the machine with and without the lamp load.

The variable speed motor is also used for calibrating car speed recorders. These speed records consist of a small generator driven by the car axle and a voltmeter

with a scale graduated in miles per hour. To test these speed recorders, the small generator is mounted on the bracket shown at the left of the generator stand, Fig. 1, just in front of the belt. The small generator is belted to the motor pulley with a round spring belt and connected to the speed recording voltmeter. The speed of the generator is then brought up to 1,000 r.p.m. as measured by a watch and speed counter. When the generator is running at 1,000 r.p.m., the voltmeter speed recorder should read 75 miles per hour and if it does not, the recorder needle is adjusted. These speed recording voltmeters are standard equipment on all C. & O. business cars and are supplied by the Electric Tachometer Corporation of Philadelphia.

Power Supply for Electric Welding*

Character of Load Is an Important Factor in Determining Method of Proportioning Charges

An electric service company which has to supply electrical energy has a great variety of loads of widely differing characteristics. Some loads are very uniform throughout the day, or even the month, while other loads require power for only short, infrequent intervals, with still others of a more or less intermediate character. It is, of course, much more expensive to supply energy to the second class, than to the first, per unit of energy consumed, and if it is possible to do so the second customer should pay more for each unit which is used.

There are three principal classes of costs encountered in serving any customer: (1) those which are proportional to the amount of energy used, (2) those which are proportional to the greatest demand for power, and (3) those which are practically independent of either. The most important element of the first item is fuel. The fuel burnt is almost the same if 100 kw. is supplied for one hour or one kw. is supplied for 100 hours. The second item is made up largely of the annual charges on the investment required in the generating station, sub-stations, distributing lines, transformers and metering equipment. Even if the investment is not used, or is used only for short periods the charges on the investment are the same and must be met. The third item includes such costs as metering and billing. It costs practically as much to read the meter, compute and render a bill for a small residence as for a large factory.

Electricity is supplied to the welding industry by the ordinary electric service company in two very different ways: (1) the direct supply to the user of welding equipment for use in electric welding, using spot, butt or arc welders and for the manufacture of oxygen. In such places as Niagara Falls, it is also supplied in very large quantities for making calcium carbide. It may surprise you to know, as it did me when I first found it out, that our company supplies much more energy for making oxygen than it does for electric welding, and, furthermore, the type of load is such that gas welding is much more profitable to us than electric welding.

Although one customer might be satisfactorily served by service of a given quality, this same service might be intolerably bad for his neighbor. For example, a fluctuation of voltage of five or even ten per cent is almost unnoticeable when applied to machine shop motors, or to elevators, but a much smaller variation is very objectionable in lighting installations.

*An abstract of a paper presented before the American Welding Society by C. W. Bates of the Philadelphia Electric Co.

In consequence of this condition it is necessary to provide a high quality of service to all customers and to require that no customer's load shall cause interference. This naturally involves considerable expense in the case of badly fluctuating loads. Under ordinary circumstances, the service company absorbs this expense, but since the customer ultimately pays the bill this means simply that the cost of service to all customers is increased instead of to those who make such expense necessary.

When welding equipment began to be used so extensively, it became necessary to investigate welder characteristics in order to enable the apparatus to be supplied with energy without causing trouble and without undue expense. Several years ago the methods which were followed in charging for electricity supplied for welding purposes were questioned in a complaint brought before the Public Service Commission. As a result, a very extensive series of tests was made jointly by the commission, one of the manufacturers and ourselves, which established the standard method of testing spot welders for the State of Pennsylvania as prescribed by the commission. This method has since been adopted by the American Welding Society and the American Institute of Electrical Engineers as the standard method for making input tests of welders during the time welds of short duration are being made.

The characteristics of various types of electric arc welding apparatus can be readily visualized by comparison with shop machinery. A single direct-current arc operated from a motor-generator set can be compared to an ordinary motor driving a line shaft in a small machine shop in which only one machine tool is used at a time. The load fluctuates from the light load value equal to that required to drive the shaft to the load value as required by the machine tool. A multiple arc welder is equivalent to the same number of machine tools driven from a common line shaft. The duration of the period during which a fairly steady arc is maintained is comparable to the time required in drilling a single hole, grinding a tool, etc. Similarly, an alternating current arc operated from a transformer may be compared to a machine tool driven by a large individual motor and which is used for fairly light work, such that the power factor never approaches the full load value.

The characteristics of the spot and butt welder was determined and the following table shows a summary of the average operating conditions together with the extremes as we have observed them:

TABLE I—SUMMARY OF TESTS ON SPOT AND BUTT WELDERS

	Spot Welders	Butt Welders
Amps. per kw or rating (220 volts)	0.55 to 20.7 6.50 avg.	0.87 to 6.40 2.65 avg.
Kva. per kw. of rating	0.13 to 4.64 1.40 avg.	0.20 to 1.43 0.60 avg.
Kw. per kw. of rating	0.08 to 2.00 0.60 avg.	0.19 to 0.63 0.36 avg.
Percent. Power Factor	24 to 89 49 avg.	25 to 89 56 avg.

This summary shows that a 20 kw. spot welder may on the average be expected to use power at the rate of 12 kw. during the short time of operation, and at a power factor such that the kva. required will be about 28.0. However, the welder may be used under such a light load that less than 2 kw. will be used or under such a heavy load that 80 or 90 kva. may be drawn by the welder. Particular attention is called to these figures as the low power consumption shows the possible small return to the electric service company, and the large kva. consumption indicates the large investment which must often be made.

A similar summary of a. c. arc welders is given in Table II. It should be noted that this table gives the actual loads of a single arc transformer and not the load per kw. of rating as in the other table:

TABLE II—A. C. ARC WELDERS

Amperes	Avg. Extremes	65 33 to 101
Kw. Input	Avg. Extremes	4.0 1.2 to 7.4
Kva. Input	Extremes Avg.	14.1 7.5 to 22.2
Power Factor	Extremes	31 11 to 49

While the a. c. arc welder is not a particularly desirable load, it can usually be accepted on the basis of 15 kva. without causing an undue amount of trouble. The question of voltage regulation has been given considerable attention. So far as the welder itself is concerned wide variations are permissible. If the resulting line voltage is low when an a. c. arc welder is in use, a higher tap may be used to obtain sufficient arc current and much the same condition results on the resistance types. However, if two or more welders are in use on the same service, they may interfere with each other. It has been found that 13 per cent drop from no load to welding load represents about the limit of satisfactory operation for any type either arc or resistance. If absolutely no other load is connected to the service transformer, it and the secondary lines between it and the welder may be quite small, merely sufficient in its rating to supply the maximum load which may usually be taken as one kva. of transformer rating (with corresponding wire size) for each kva. of welder rating.

When, however, motors or lights are to be operated from the same transformer, the conditions are much more difficult to satisfy. In Pennsylvania, the State Commission specifies "that for service under lighting contracts and under power contracts the voltage variations shall not exceed plus or minus 5 per cent and 10 per cent, respectively, of the standard service voltage for more than one minute." This is typical of all commission requirements, but most service companies try to give much better service.

In order to approach these figures, it is necessary to separate, as far as possible, the welder supply wires from those supplying lights and motors. The drop in an ordinary transformer from no load to full load will range from 3 to 4 per cent on low power factor loads, i.e., from 6.9 to 9.2 volts on a 230-volt winding. Using 115-volt lamps the voltage variation across the lamp will be 3.5 to 4.6 volts or 1.5 to 2 per cent. It will be seen that this gives little margin for line drop outside of the transformers, and since a flickering or fluctuating light is much more annoying than a dim light which has a steady intensity equal to the low extreme of the flicker, we have considered that the effect of the fluctuation due to welder should be limited to about half the value given above, or to ¾ to 1 per cent. That is, a transformer which is to supply other loads in addition to the welder must be roughly twice the size (in kva.) of the welder supplied by it. Our working rule formulated before the adoption of the kva. rating for welders is that the kva. rating of a transformer shall be at least 2.0 to 2.5 times the kw. rating of the welder. On this basis, the 20 kw. welder used as an illustration would be supplied by a 40 to 50 kw. transformer. The necessity of using commercial sizes of transformers limits us to 50 kva. the next lower size being 37.5 kva. Even using this size of transformer, it is necessary to run separate secondary wires from the transformer for lights and for welder and to use separate meters. Motor loads might usually be supplied by the same wires as the welder, but it is better to combine the lights and motors, thus following the ordinary practice.

Another important factor from the economic standpoint is the time of operation of a welder. The time required to make a single spot weld varies a great deal with the requirements of the work ranging from 0.2 to 2.0 seconds with an average of about 1.0 second. A typical cycle while welding a total of ⅛ in. of steel is: welding 1 second, moving piece 2 seconds, welding 1 second, etc., for 6 to 10 welds followed by an interval of 15 to 30 seconds to change and adjust a new piece. There will also be idle intervals, so that it is reasonable to assume that the welder is in use for about one-tenth of the time.

Butt welders operate on a more continuous cycle being used for about one-fifth of the time on the average. Otherwise their characteristics are identical with those of the spot welders. Arc welders may be taken to be in use for one-third of the working day.

Continuing the example, assuming that the 20 kw. welder is used at the average load, i.e., 12 kw., for a ten-hour working day, it would be in use for 19 per cent of the time, that is, one hour. The daily use would then be 12 kw. hr, which must be supplied by a 50 kva. transformer. If this transformer were used for supplying a shop motor at 80 per cent power factor and loaded to an average of 70 per cent for the entire day, it would supply 280 kw. hrs. That is, over 23 times as much energy would be sold by means of facilities which cost equal amounts. We believe that the welding customer should pay for the use of these facilities and not shift the burden to the other customers.

Safe navigation of merchant vessels depends largely upon efficient radio equipment. At the present time there are approximately 2,750 American ships equipped with radio, not including government vessels. During the past year 7,721 inspections were made for the protection of the traveling public, as compared with 6,933 of the previous year. During the same period 1,577 inspections were made of ships voluntarily equipped, compared with 1,124 the previous year, and 974 American ship stations were inspected for licenses, compared with 644 the previous year.

General View of the Car

N. Y. C. & St. L. Dynamometer Car Number X50041

Modern Electrical and Mechanical Devices Make It Possible to Secure Most Elaborate Test Records

By H. A. Leatherman

THE Nickel Plate Dynamometer Car is now ending its first year of successful service. While it is doubtless true that the car is of greatest interest to the mechanical engineer, it is also true that without the intimate co-operation of the electrical engineer, the amount of information obtainable as well as the high degree of accuracy with which it is obtained would be greatly diminished, if indeed possible.

The purpose of the car is to obtain data on locomotive operation, track conditions and permissible tonnage, that when worked up into suitable form will guide the motive power and operating departments to function with greatest efficiency. Fifteen functions are charted on the travelling roll of paper that is fed through the chronograph table, as will be later seen. These fifteen functions are: 1. Draw Bar Pull, 2. Draw Bar Buff, 3. Speed, 4. Train Line Air Pressure, 5. Brake Cylinder Air Pressure, 6. Locomotive Steam Pressure, 7. Time Intervals, 8. Locomotive Throttle Position, 9. Reverse Lever Position, 10. Integration of the Area under the Draw Bar Pull Curve, 11. Mile Post Location, 12. Distance Travelled, 13. Right and Left Hand Indicator Cards, 14. Track Curve, 15. Coal Fired.

From this list it can be seen that so complete a collection of data, when worked up into report form is of inestimable value in determining economical operating factors.

Above is a general external view of the car, which is 53 feet, 7 inches long. The underframe is a specially designed steel casting to withstand the severe stresses of buff and pull encountered between the locomotive and a long string of loaded box cars. The superstructure is of steel, lined with pine interior. The general floor plan is shown in Fig. 1.

A view of the operating room with the transmission unit in the foreground and the chronograph table in the background is shown in Fig. 2.

The opposite end of the operating room taken as one stands with his back to the chronograph table is shown in Fig. 3. Note the general lighting arrangement consisting of 50-watt type C lamps in steel reflectors, aided by generous local lighting, particularly over the work table at the left where 25 watt lamps in Alba reflectors are used.

Commodious quarters are provided for the crew. Six Pullman type berths are provided for the men; there are also a bath room with shower bath, cook's room, kitchen and dining room. Fig. 4 is a view of the dining room. Detachable tables are attached between the seats when serving meals, and the same seats made into a comfortable lower berth for sleeping, the upper berth being shown in the picture.

Energy for lighting as well as for the operation of the instruments is derived from a 4-kw. Safety belt-driven axle lighting generator which charges two sets of A8HW Edison batteries of 25 cells per set. One set is worked while the other charges, manual switching from one set to the other is provided for by the Safety type F wiring scheme, the lighting fixtures, fans and generating equipment in general is of Safety manufacture. The telephone

used between the car and the locomotive was provided by the Western Electric Company, this telephone set has special transmitters to get the maximum volume of sound to the opposite head phones. The chronograph table motor is of General Electric manufacture, with special centrifugal speed regulator, which can be seen attached to the near end of the motor shaft in the foreground of Fig. 2. The other electrical instruments were supplied by the Burr Company of Champaign, Illinois, which designed and built the car. A 1-kw. transformer is also provided for lighting the car with alternating current while in yards for long periods of time. The panel controlling the lighting is so arranged that the alternating current does not pass through the lamp regulator but is fed directly to the lighting circuits. The fan circuit is also taken around rather than through the lamp regulator.

The obtaining of the draw bar pull or buff record is a purely mechanical and hydraulic arrangement in which the tension or compression stresses incident to pull or buff are transmitted from the draw bar to a piston which creates hydraulic pressure in its cylinder. This pressure is in turn transmitted to an indicator not unlike the conventional steam indicator in principle and construction. Even here however the electric man gets in his little word, for an electric bell alarm is provided to call attention to a deficiency of operating liquid. The electric contact box may be seen just below the lifting ring on the "weighing head" as the device is called, in Fig. 5.

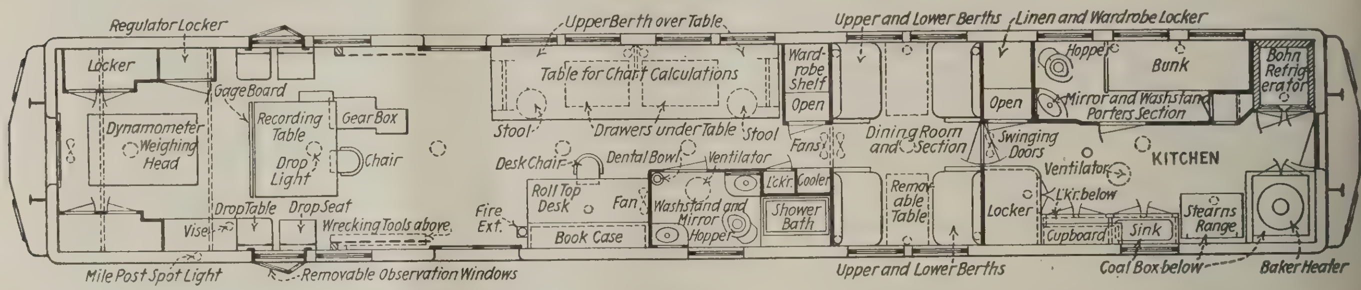


Fig. 1—Plan of Car Showing the Location of the Various Equipment and Facilities

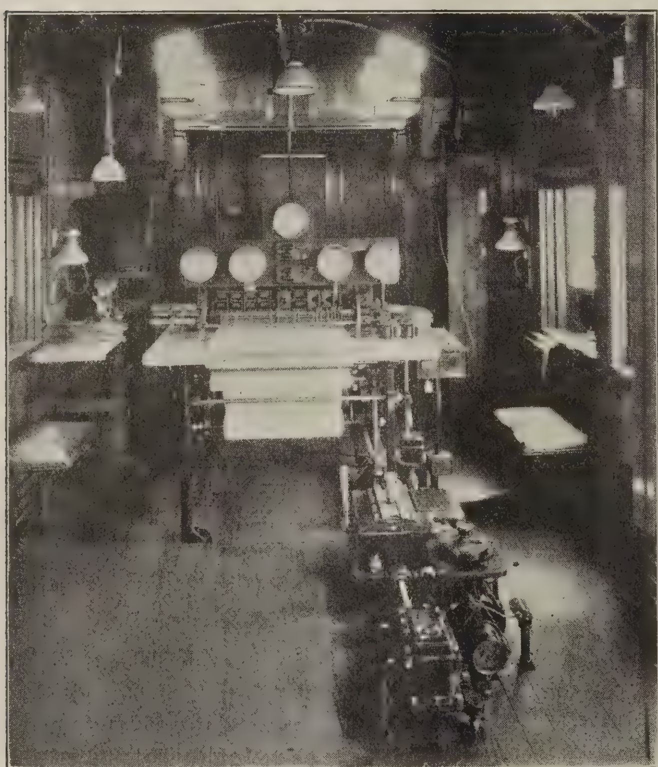


Fig. 2—Operating Room with Transmission Unit in the Foreground and Chronograph Table in Rear

Both the speed indicator gage (to the left of the table in Fig. 2) and the speed recorder are mechanically operated and hence call for no particular discussion here.

Train line air pressure, brake cylinder pressure and reverse lever position are indicated and recorded without the aid of electrical devices, the pressures being read on conventional Bourdon tube gages. Locomotive steam pressure is read by the attendant on the engineer's gage in the locomotive cab, and telephoned to the operator in the car together with the back pressure, throttle position and any other desired data.

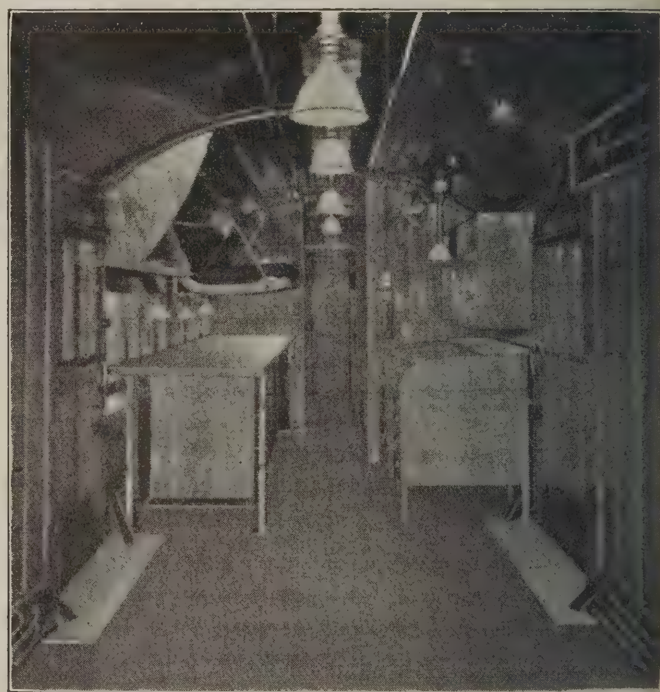


Fig. 3—Opposite End of Operating Room Looking from Chronograph Table

Two time intervals are recorded electrically, six second intervals and one minute intervals. The six second record is made with a pen which is fastened to the armature of an electro-magnet which is not unlike the ordinary telegraph sounder turned on edge. These magnets with their pens can be seen on the table in Fig. 2.

The circuit through the magnet winding is closed by a contact mounted on the driving shaft of the speed re-

corder, which shaft is in turn driven by the motor referred to. This contact closes every 180 revolutions of the motor and so accurately is the speed regulated by the centrifugal governor (centrifugal weights operate contacts that short out a portion of the field rheostat) that the variation in six second intervals due to irregular motor speed are not perceptible.

The six second record is checked against a one minute interval which is recorded by the regular magnetically operated pen, the controlling contacts are located in a

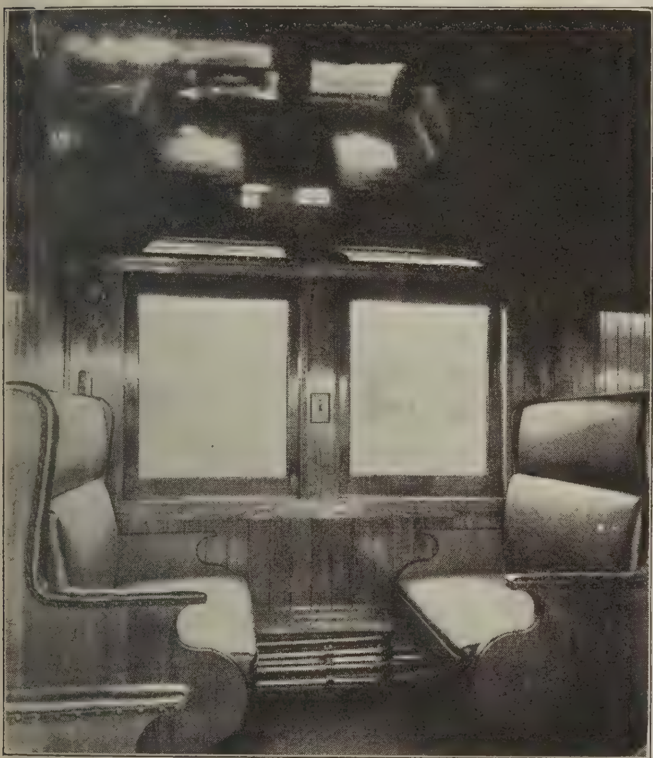


Fig. 4—Detachable Tables Placed Between Seats for Dining Room Facilities. Same Seats Can Be Made Into Lower Berth for Sleeping

Seth-Thomas chronometer. The chronometer and the relay in this circuit are seen in the center of the table in Fig. 2. In addition to operating the pen, this clock circuit also operates a Veeder counter each time that the contact is closed, so that the result amounts to an integration of the test time, read directly in minutes on the counter.

The integrator for the draw bar pull curve is an adaptation of the familiar polar planimeter. Each revolution of the integrating wheel closes a contact which controls the circuit through the integrating relay (lower relay under clock in Fig. 2) which in turn operates a counter as well as an indicating pen, quite the same as described for the one minute signal.

Mile post location is indicated by a pen controlled by a push button which is operated by an observer who presses the button as each mile post is passed. Spotlights of the familiar "through the windshield" type aid in locating mile posts after dark.

A shaft driven by the axle of the car carries the distance contact which closes every one hundred feet of car motion and is indicated by its pen in the same manner as the other functions described.

The track curve pen is mechanically operated by a pantagraph arrangement on the king pin. The coal fired, and time of taking indicator diagrams are worked by push button signals from the engine cab.

The telephone and signal lines utilize a twelve conductor cable which terminates in a 13 (1 spare) point plug and receptacle on the end of the car, and a terminal board in the engine cab. Convenient means for quickly stretching this cable from the car to the engine, and again taking it down and storing it in the car are provided.

All the instrument wiring is located in conduit underneath the car floor, with condulet covers flush with the floor to facilitate easy removal for repair or change.

Several other pen-magnets are provided for any other functions that might be desirable to add later.

Ordinarily a crew of four men and cook comprise the roster. One man rides in the locomotive cab and phones back the lever positions, back pressure, etc., one man reads the mile posts as they are passed, and one man operates or rather watches and supervises the chronometer table. The extra man being a relief man. During the trip one hears the whir and whine of the motor punctuated by the incessant clickety-click of the hurrying pens and once every mile the droning voice of the operator as he takes data from the cab man. The end of a run usually finds all hands scampering off for a well earned

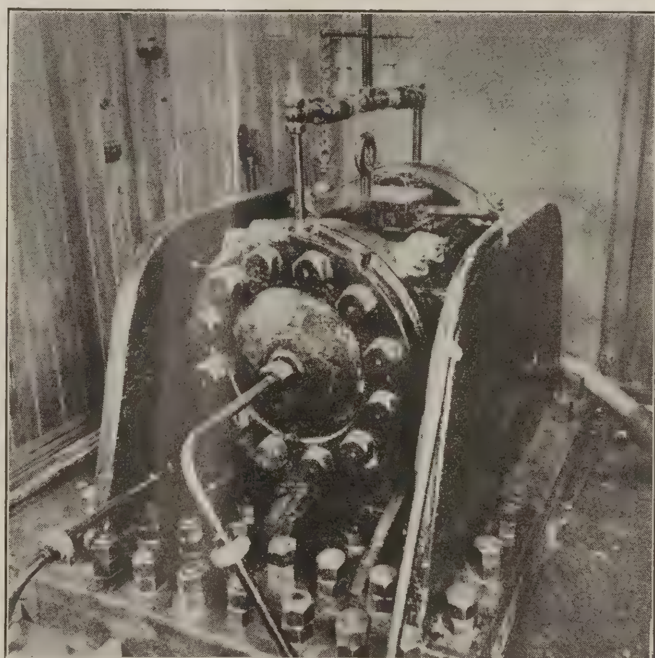


Fig. 5—Cylinder Used in Measuring the Tension or Compression Stresses Incident to Pull or Buff Transmitted From Draw Bar

sleep. Rest and recuperation from the intense strain of careful and vigilant watching are indulged in for eight hours, and then all hands turn out to "work up the reports." The data is scaled off the paper, called off to the computer and his deftly shifted slide rule convert the jagged lines of the record into an accurate statement of what the equipment is doing, the report is mailed to the "old man," and the run is over.

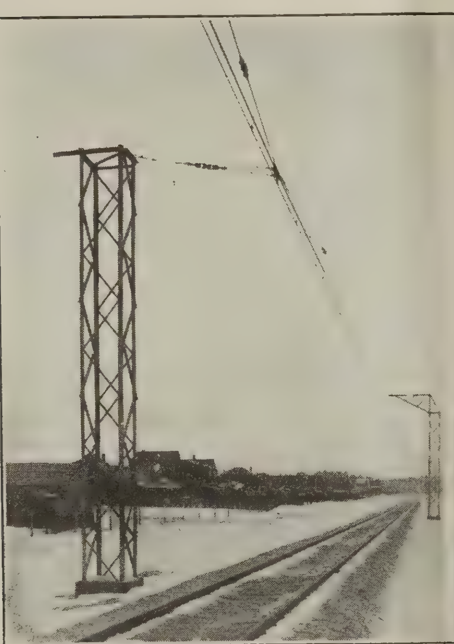
The export of generating equipment shows a considerable increase in both direct and alternating current apparatus of all classes. The most notable increase has been in alternators of over 2000 Kva capacity.

Canadian National Erects New Catenary

Specially Developed Structural Supports and Steel Cored Aluminum Messenger Wire Mark Recent Design

By E. B. Walker
Electrical Engineer, Canadian National Railways

THE Canadian National Railways have included in their system a number of electrified sections of 600, 1,500 and 2,400 volts, direct current and 3,300 volts alternative current, single phase. These vary from local street car lines and interurban lines to main line electrification. Extensions are made from time to time and new sections considered for electrification and with this in view it is felt that an effort should be made to standardize some type of overhead construction which would, in some measure, include the advantages of permanent steel construction and the low cost of wood poles. This construction had also to be suitable for any of the above voltages and for pantograph or trolley wheel operation.


Standard Anchorage for Different Heads


Standard Tangent Construction


Showing High Tension Extension

A review of existing systems, with a personal inspection of the more important examples, was made. It was felt that they could be roughly divided into three classes:

1. Wood pole construction with 150 ft. spacing.
2. Light steel poles with 150 ft. to 180 ft. spacing.
3. Steel bridges and heavy steel poles with 300 ft. spacing.

After investigating these systems it was felt that with the exception of 150 ft. spacing on wood poles, none of the others showed very much effort to make use of the full economy of steel construction. The shorter spacing with light poles did not allow any economy in comparison with wood construction, and where the longer spacing was used most of the structures were very much stronger than necessary for the actual stresses to which they were subjected, and the cost of this construction was unduly great, except where there were a number of tracks to be electrified.

The new construction under consideration had to be designed for single track operation and for a total conductivity of 500,000 c.m. of copper. At the same time, it had to be clearly shown that the capital cost was not sufficiently above the cost of wood pole construction materially to increase the total cost of the electrification. Accordingly, a study was made of the different materials and fittings available, which resulted in the adoption of the following:

Trolley Wire

The present portion of the line has been operating for 7 years without renewing the trolley wire which consists of 4/0 hard drawn copper. The various special bronzes were considered, but it was felt that the increase of total weight of the overhead construction caused by the reduced conductivity of the bronze, together with the increased cost, formed a distinct drawback especially in view of the excellent service already obtained, and, consequently, it was decided to adopt 4/0 standard grooved section hard drawn copper trolley.

Messenger and Feeder

In order to balance in some part the increased cost of steel or concrete poles as compared with wood poles, it was felt that the longest spacing compatible with safe construction should be adopted. Investigation of existing systems showed a maximum spacing of 300 feet, using very substantial steel construction. There did not seem

to be any logical reason, however, for stopping at 300 ft. and an effort was made to balance what we considered a maximum sag of 6 ft. with reasonable messenger tensions.

Another consideration of the long spacing was the necessity for providing feeders of more tensile strength than ordinary copper, and, at the same time, of high conductivity. The natural result of the combined requirements of high tensile strength, high conductivity and light weight led to an investigation of the various composite cables and to the final adoption of steel cored aluminum.

As we required a feeder conductivity equal to about 300,000 c.m. of copper, we had to have a cross-section equal to 477,000 c.m. aluminum. We, therefore, had specially made a cable consisting of a 7-strand steel core and two layers amounting to 30 strands of aluminum, each strand being .1261 inch in diameter. High tensile strength steel was used, giving an elastic limit of 16,600 lb., and an ultimate strength of 22,600 lb. and a total weight of 3,944 lb. per mile. As this weighed less than an equivalent of copper cable, it was felt that we could make our spacing longer than usual, as the very light weight of the overhead system would keep the sag at a low point. After a careful investigation it was finally decided that a normal spacing of 330 ft. on tangent track be adopted, with a maximum sag of 6 ft. at normal temperature, and with a normal messenger tension of 3,600 lb.

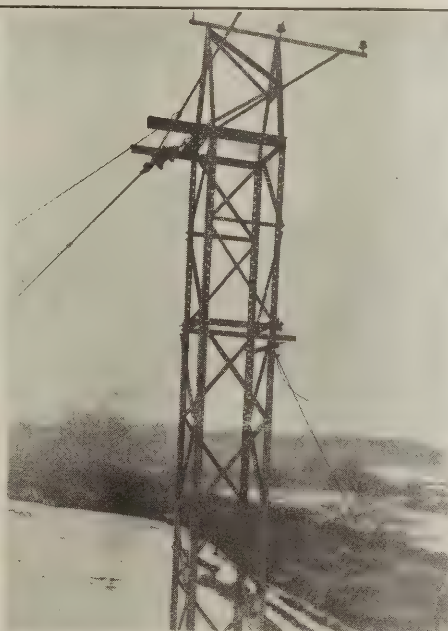
While the unusual length of this span may be questioned, on the other hand, the low weight of the overhead system must be borne in mind, the result being that the actual loading is very much less than on many systems with 300 ft. spacing. Calculations as to the maximum conditions of ice and wind loading showed a tension not exceeding 7,500 lb. which left us with a factor of safety of more than two-to-one in the elastic limit of the messenger.

Telephone Dispatching Wire

Where only a small number of telephone circuits are required a short steel arm was provided by extending one of the angles of the tower so that the telephone circuit could easily be carried at the rear of the pole. A special type of telephone wire was necessary because of the long span and two types were adopted for different conditions. Where conductivity was of importance a steel cored aluminum cable consisting of one high tensile strength steel wire .1052 in. in diameter and six strands of aluminum of the same size was used. In other cases where the telephone traffic was light a No. 8 B.W.G. special steel wire similar to the Bell Telephone River Crossing wire was used with perfect satisfaction.

At points where it was necessary to carry this telephone circuit across the catenary system to poles on the other side, the high tension extension was used. This extension was really developed for carrying high tension wires but it formed a very convenient method of carrying over the telephone circuit. The two outside pins were used for the telephone insulators and a long inside pin was mounted without insulator to prevent a telephone wire from slipping off the arm and falling on the catenary system in case it should become loosened from the insulator.

Pole with Adjustable Head



Adjustable Head and High Tension Extension

Armless Pole on 4 Degree Curve

Poles

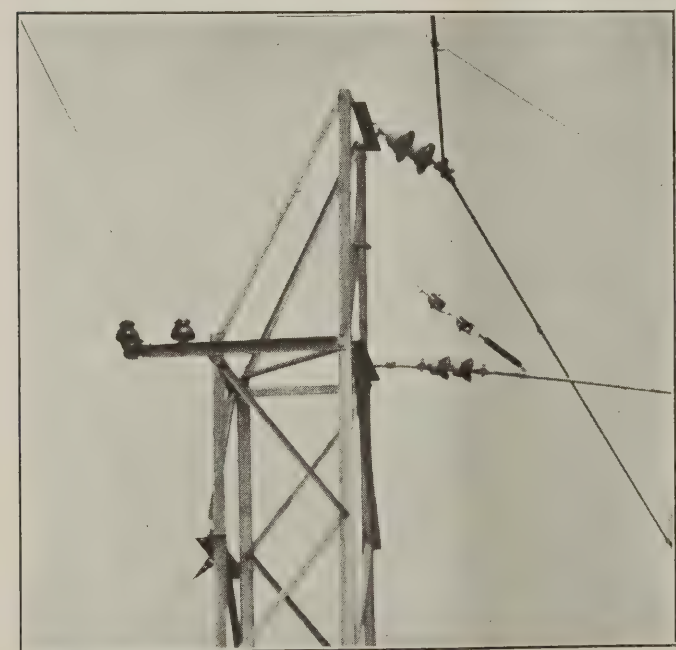
The stresses calculated for ice and wind loading showed that a pole of considerable strength would be required, and a number of types were investigated, including various forms of concrete, "H" sections, fabricated poles, both triangular and four-sided. It was finally decided to adopt a pole built up of hot galvanized angles in the shape of a square tower with parallel sides. This type of pole lends itself to catenary construction where inclined hangers are used. It is easy to design all the special fittings required for different types of curves, and in the end we were able to obtain an excellent range of adjustment by the use of a standard pole and different heads. The pole was 2 ft. 6 in. square on the base and up to a height of 24 ft. above the rail was the same for all conditions. On this standard shaft, however, could be fastened the following combinations:

1. The standard arm for tangent construction.
2. The short arm for curves up to 1 degree.
3. The adjustable head for suspension of the messenger on curves up to 2 degrees.
4. The armless pole with adjustable fittings on the face of the pole for curves of 3 degrees to 5 degrees.
5. An extension for carrying three high tension wires when necessary.
6. A short pole used for anchorage.

The illustrations will show clearly how these combinations were worked out and we feel that it would have been difficult to have managed them so simply with any other type of pole, especially in view of the specifications for maximum loading.

The calculations for maximum ice and wind loading show that the pole should have the following capacities: 1,000 pounds vertically at the end of the catenary arm over the center of track, plus 1,000 pounds horizontally at the same point in a direction normal to and towards the track.

We also felt that a reasonable amount of rigidity should be allowed in a direction parallel with the track at the end of the catenary arm and the pole was designed to stand 1,000 pounds in this direction. Actual tests of a sample pole showed that these figures could be practically



Construction Details at Top of One of the Armless Poles

doubled before failure, thus maintaining our original safety factor of two-to-one.

Insulation

Owing to the loss of insulation due to the use of steel instead of wood poles, it was felt that a higher grade of insulators would be required. A two piece pin type insulator of substantial design was investigated for the catenary arm, but it was eventually decided to use a 5 in. x 5 in. x 4 ft. impregnated oak block set into the end of the catenary arm through which a hole was bored for the insulator pin and ordinary single piece insulators were used. The oak block in itself gave ample insulation for 1,500 volts, and at the same time made it impossible for the messenger to touch metal work of the arm, even if it were broken entirely free from the insulator.

On curves of 1 deg. 40 min. and over a suspension type of insulator was used consisting of two standard units, each of which had ample insulation for the line voltage.

The various types of catenary hangers used in existing installations were investigated and it was felt that most of them were unnecessarily heavy for the strains actually produced. An effort, therefore, was made to design special hangers of light weight, with a result that a tangent hanger with a ¼ in. single rod and a malleable casting was used and the hangers on curves were reduced from

Armless Pole on a 3 Degree Curve on the Niagara, St. Catherines & Toronto

the usual ½ in. rod to ⅜ in. by buttwelding a ½ in. piece for the threaded end.

As the lines in question are operated electrically or with very light steam service, it was not thought necessary to use non-ferrous metals, consequently, all fittings were made of steel or malleable iron hot galvanized. Owing to the fact that aluminum is very soft and easily abraded, all insulator points were well wrapped with aluminum tape both tied and clamped into position. It was also felt that wear might be expected from the movement of the catenary hangers on the messenger; consequently, a special aluminum stamping was designed with projecting lugs, which could be clamped on the messenger, allowing the hanger to ride easily over it and at the same time preventing displacement of the hanger by projecting lugs.

The results are very pleasing to the eye. The long distances between poles and the absence of pull-offs and special curve fittings is in marked contrast to the older construction where the spacing is 150 ft. on tangent down to 75 ft. on curves. The inclined type of construction allows the following spacing:

Tangent—330 ft.
Curves up to 2 degrees—330 ft.
Curves up to 3 degrees—285 ft.
Curves up to 4 degrees—240 ft.
Curves up to 5 degrees—210 ft.

The latter is the highest curvature in the new construction and no design has been made for anything greater.

The first section of this class of construction was installed on a two-mile extension of the Canadian National

Electric Railways, Toronto suburban division, and the majority of the illustrations are taken from this section. This line is operated at 1,500 volts, direct current.

Shortly after six miles were installed on a branch steam line between Port Dalhousie and Merritton, which has been taken over by the Niagara, St. Catharines and Toronto Railway and will be operated at 600 volts, direct current.

Since this orders have been placed for the necessary material to extend the electrification of the Montreal tunnel from the present terminal at Lazard to St. Eustache, a distance of 10 miles. This will be operated at 2,400 volts with multiple unit cars. This section is part of the main line of the old Canadian Northern between Montreal and Ottawa.

While nearly every point in connection with this construction had to be specially developed, the result has worked out in an entirely satisfactory way from the point of view of appearance and strength, and, at the same time, the cost has not exceeded high-class wood pole construction by more than 10 per cent.

In preparing the plans for this work the assistance of the engineering staffs of the Northern Aluminum Company, the Ohio Brass Company and the Canadian Bridge Company was of the utmost importance, both in the general design and in working out the details of the different parts of apparatus.

Electrical Characteristics of Brushes*

There are three main divisions that can be made in the study of carbon brushes. They are: First, electrical characteristics; second, mechanical or physical characteristics; and, third, brush composition. This article will deal only with the electrical characteristics and it is the aim to give these characteristics in detail in order to give everyone connected with the electrical industry a better

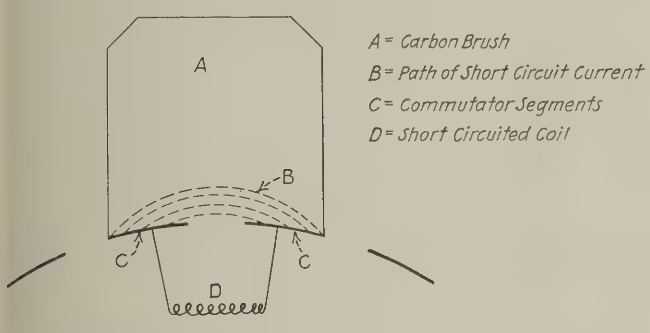


Diagram Showing the Factors in Commutation

understanding of the principles employed by brush engineers in solving brush problems.

The electrical characteristics of a brush can be classified as follows:

1. Specific resistance.
2. Contact resistance.
3. Variation of specific resistance and contact resistance due to heating.
4. Carry capacity.

Specific Resistance

The specific resistance of any material is the resistance in ohms of a cube of this material whose sides are one inch long. It is obvious that the specific resistance of brushes is dependent on the material from which they are made. In calculating this specific resistance or resistance per inch cube, the following formula is used:

$$R = \frac{K \times L}{W \times T}$$

R = Total ohmic resistance of the brush.
K = Specific resistance in ohms per inch cube.
L = Length of the brush in inches.
W = Width of the brush in inches.
T = Thickness of the brush in inches.

It has been found that the resistance varies in carbon and graphite brushes from a maximum of .004 ohm per inch cube to a minimum of .0001 ohm per inch cube. Brushes made of a composition of graphite and copper have a specific resistance as low as .0000032 ohm per inch cube.

Contact Resistance

Contact resistance of carbon brushes is the resistance between the commutator and the brush when the current is flowing. Contact resistance becomes less as the current density increases until the brush begins to glow, when the resistance rises suddenly, due probably to the oxidation of the commutator.

Carbon has a negative resistance coefficient and therefore, as the brush heats up the specific resistance decreases. The contact resistance, however, varies but little with change in temperature under normal conditions. In fact, for all practical purposes it is safe to assume that an increase or decrease of temperature has no effect on the contact resistance. The variation of contact resistance is practically in an inverse ratio to the current density so that the contact drop—that is, the voltage drop across the contact between the brush and commutator—is approximately uniform for all current densities within the range of normal operation.

Carrying Capacity

Carrying capacity is the current density in amperes per square inch of contact surface that a brush can carry without serious heating. In giving a figure for carrying capacity the brush engineer not only considers the actual load current, but also the short circuit currents and the heating produced by friction and contact drop. Carrying capacity, while primarily an electrical characteristic, is subject to pronounced influence by all of the mechanical or physical characteristics of brushes having any influence on the temperature. These mechanical or physical characteristics are: First, coefficient of friction; second, abrasiveness; third, density; and, fourth, thermal conductivity.

The Effect of Specific and Contact Resistance

While the specific resistance of a brush has some effect on the commutation of a machine, the effect is not as marked as that of the contact resistance. A high specific resistance brush tends to reduce to some extent, the short circuit currents on the brush face, but its effect is not very important in this regard. A more important advantage is the tendency to reduce short circuit currents between the brush stud which may be caused by improper brush spacing. The chief disadvantage of high specific resistance is the high heat loss due to passage of current which increases the temperature of a commutator and consequently decreases rating of the machine. On the

*From a bulletin issued by the National Carbon Co.

whole, disadvantages of a high specific resistance brush would greatly outweigh the advantages were it not for the fact that high specific resistance and high contact resistance usually go hand in hand.

In general, contact drop is less in a graphite brush than in an amorphous carbon brush and varies but little with changes of temperature. It must be remembered that the contact resistance, and therefore, the contact drop, depends not only on the condition and character of the brush and commutator, but also on the brush pressure.

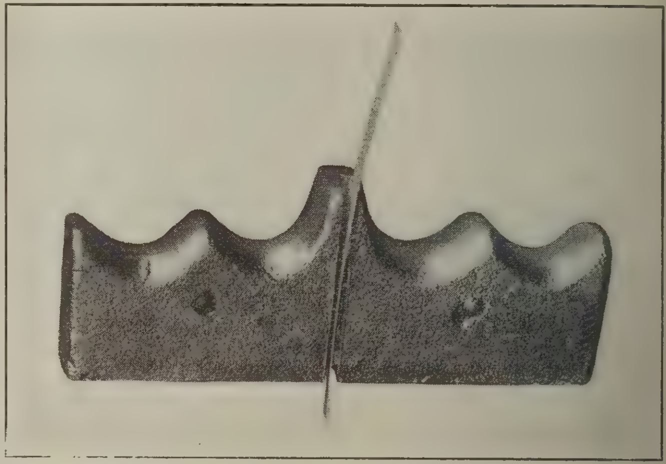
The resultant effect on the load current, short circuit current and contact drop frequently heats the brushes to a red heat or to the "glowing" point. Glowing of the brushes is always accompanied by pitting or disintegration of the faces of the brushes which reduce the available contact area and increase the current density through the balance of the brush, causing a further rise in temperature. Picking up of copper is another fault that frequently accompanies glowing. The carrying capacity determines whether or not the load current will produce serious heating. The short circuit currents may also cause serious heating and glowing of the brushes even if the carrying capacity is sufficient to take care of the load current. The value attained by the short circuit currents depends on both the specific resistance and contact resistance. For example, a low contact drop between the brush and the commutator together with a relatively high reactance voltage would cause a heavy short circuit current to flow through the brush and cause the brush to heat. This heating causes a reduction of the specific resistance and in turn causes a still larger short circuit current to flow. This increased current again increases the temperature. This process continues until the brush is heated to incandescence or to the "glowing" point. The characteristics which make a brush valuable on the machine having a high reactance voltage are a combination of low specific resistance and high contact resistance, thus insuring a brush of greater conductivity with sufficient resistance to cut down the short circuit current.

Unequal distribution of load current among the brushes will cause certain brushes to heat up due to the excessive current and reduce the specific resistance, thereby causing them to carry a still greater portion of the load and heat up to the blowing point.

The illustration shows the path of the short circuit currents through the brush which in this case covers two commutator segments. A brush always covers more than one segment and on many machines covers three or more segments. The value attained by the current in a short circuited coil depends upon the contact resistance, the resultant voltage and the specific resistance of the brush. Of these three factors, the first two have the greatest influence, specific resistance having only a minor effect.

Electrician's Snake Puller

An electrician's snake puller which is designed to grip the snake without damage to the hands or to the snake has been brought out by Walter S. Sweet, 308 East Fourth street, Los Angeles, Cal. It consists of an aluminum casting with a contour which fits the palm of the hand, allowing the fingers to lie naturally in grooves provided. The snake is gripped by two cams pivoted eccentrically and so arranged that they grip opposite sides of the snake as it lies in the groove on one side. The harder the pull the tighter the grip, but the snake can be instantly released by slackening the tension.



The Grip Will Not Injure the Snake and the Snake Will Not Cut the Hands

Underwood & Underwood

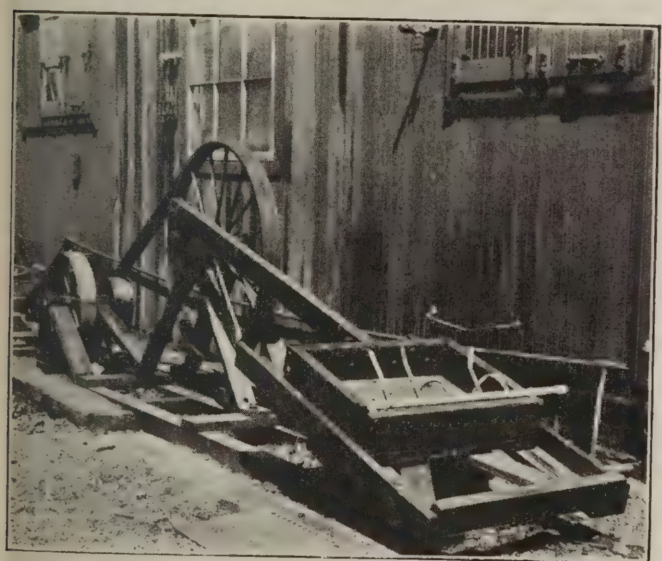
Chicago Union Station, Now Nearing Completion

The Interchange

Shaker for Edison Batteries

A shaker for washing sediment out of Edison storage batteries, recently built and put in service by J. H. Wilson, chief electrician of the Norfolk Southern, is shown in the illustration. The shaker is made almost entirely of scrap material and it most effectively does the work for which it was built.

The machine is driven by 3 hp. 1,200 r.p.m. motor. This is a much larger motor than is actually necessary, but it was used because it was available when the shaker was first put in operation. A ¼ or ½ hp. motor would probable be large enough. The motor has a 4½ in. pulley belted to the larger pulley on the jackshaft, which is 24 in. in diameter. The smaller jackshaft pulley, which is 12 in. in diameter, is belted to the large wheel which measures 44 in. This large wheel was taken from an old two-wheel push cart and as used in the shaker, it is mounted on a short shaft having a 9-in. crank on one end.



Motor Driven Battery Shaker

The connecting rod is made of a piece of wood, 2 in. by 5 in. in section and 6 ft. long. The crank pin is fitted into one end of this piece and the other end is fastened rigidly to the battery shaking tray, with angle iron and bolts. The shaking tray is large enough to hold 5 cells at a time. It is built of 2 in. lumber bolted together and is 26 in. wide, 20½ in. and 5 in. deep inside. A piece of ¾ in. pipe is strapped across one end of the box. This pipe is capped at one end and is connected by a rubber hose at the other end to the water supply. At equal distances along the pipe it is fitted with five ⅛ in. nipples and a piece of rubber tubing about 8 in. long is slipped over each nipple. The guide box in which the shaking tray slides is also made of 2 in. lumber and is pivoted on two bearings at the center. The shaker tray slides on two pieces of ¼ in. by 1 in. flat iron strips fastened to the guide box.

When the batteries are brought in for overhauling, the cells are removed from the battery trays, are cleaned inside and out and painted. The shaker takes care of the inside cleaning. After the old solution has been poured out, five cells are placed side by side in the shaker tray with the vents or filler openings at the front or low side of the tray. They are wedged tight in the tray with wooden wedges. The five rubber tubes are pushed into the filler openings and the water is turned on so that a slow stream runs into each cell. The motor is then started. This shakes the tray back and forth about 60 times per minute. It also imports a rocking motion to the batteries, which aids in removing the sediment and as the filler openings are at the lower end, the sediment works its way out quickly.

Lighting Batteries for Bell Ringing

It is quite common practice to use dry batteries for the operation of annunciators and bells in railway cars, but this is by no means imperative on cars which carry the regular 32-volt storage lighting battery.

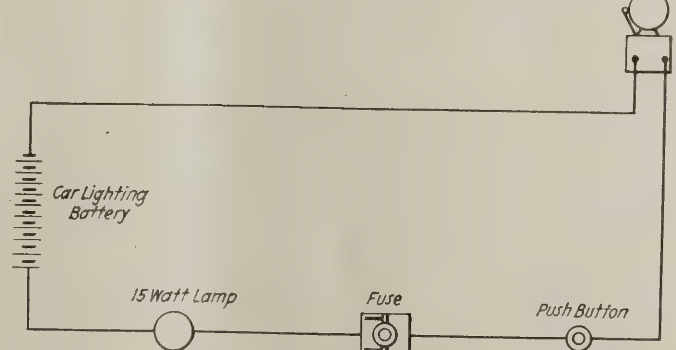


Diagram of Connections for Operating Bell From Car Lighting Batteries

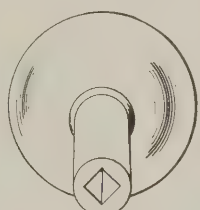
There may possibly be some objection made by some of the car lighting men, that it is undesirable to connect

the car lighting batteries with annunciators and bell circuits. The fact remains that on the Delaware, Lackawanna & Western, where this system has been in use on a number of cars, it has given complete satisfaction. Diners, club cars and private cars have been equipped, and some of these have been in service for more than five years, and none of the installations has given the least trouble. It has never been necessary even to clean the contact points on the electric bells.

The circuit used is shown in the diagram. The actual connection to the car lighting battery circuit is by two wires tapped to the bottom of the main battery switch. A 15-watt lamp is provided, and also an Edison fuse block and plug. This fuse affords ample protection to the circuit. The lamp filament performs the function of saving the spark contacts of the bell. It is not necessary that the battery be fully charged to operate the annunciator or bell system, for even if the batteries were only furnishing 15-volts, the bell circuit would still operate.

Boring Holes in Close Quarters

A useful addition to the wiremen's tool kit is an ordinary door knob. The hole in the shank of the door knob is of



A Simple Door Knob May Be Useful Where a Brace Can Not Be Used

the proper size to hold the square shank of a wood bit and will be found very well adapted for that purpose when drilling holes in close quarters.

To the Minute

A traveling Charlestonian paused one night at a small up-state town, one of those places where trains don't really stop—they merely hesitate. Its lone hotel, opposite the railway station, was kept by an aged darky, who was proprietor, clerk, cook, waiter, bellhop and everything.

"Call me for the three-fifteen train," ordered the guest, retiring early—to sleep soundly until awakened by a loud hammering on his door.

"Hey, boss," came a voice outside, "didn't youh-all left a call foh de three-fifteen train?"

"Sure," gasped the roomer sleepily.

"Well, suh," was the response, "she's at de stashun now."

Flattery

An editor, apropos of William Dean Howell's 80th birthday, said:

Mr. Howells is as modest as he is gifted. His publisher once showed him a sketch for a prospectus that praised him warmly. Mr. Howells drew his pencil through certain over-warm adjectives and said they made him feel like a young widow.

"A young widow," he explained, "had carved on her husband's tombstone when he died the inscription:

"Sacred to the memory of John Doe, who departed this life in the 57th year of his age, bitterly regretting he must leave the most beautiful and best of wives!"

Why Wait?

Come ahead. You're unimportant.
Don't stop. Nobody will miss you.
Try our engines. They satisfy.
Take a chance. You can get hit by train only once.

THE QUESTION CORNER

Answers to Questions

1. *Can I charge a 6-volt battery from city current which is alternating?*

2. *How high can I run up the specific gravity with the battery down to* 1,100?

3. *Which is the best current, a. c. or d. c., to charge with?*

Charging 6 Volt Battery

The small 6-volt storage battery which is so extensively used at the present for radio purposes may be charged in several different ways. By far the greater number of persons using these batteries are located so that charging from a. c. circuits is imperative. This is no drawback, however, and as a matter of fact it is usually cheaper to charge from 110-volt a. c. than from 110-volt d. c.

It is, of course, always possible to connect five or six 100-watt lamps parallel so that a current of five or six amperes will be drawn from a 110-volt d. c. line. If this circuit is passed through a six-volt storage battery, taking care that the polarity is correct, the battery will be charged. Needless to say this method is expensive.

Those who have the alternating current source to draw from, which is the majority, do not have to use so wasteful a method.

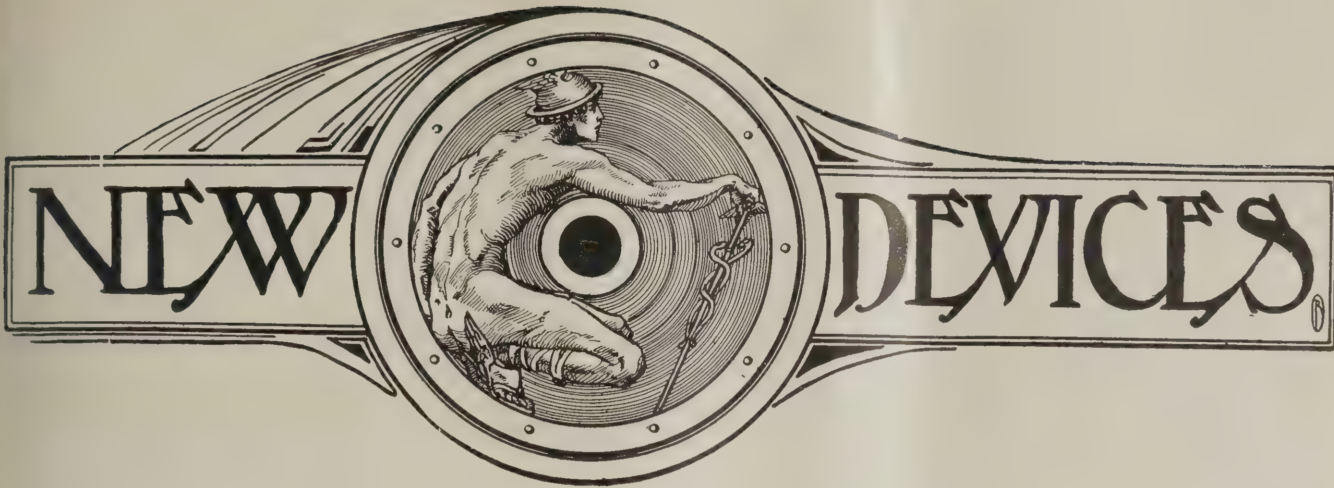
There are on the market today a large number of rectifiers. These are built on five different principles, namely, the magnetic vibrator, the commutator, the mercury arc, the vacuum tube and the electrolytic.

2.—The specific gravity of a storage battery is probably the best indication that can be had regarding the state of the charge. Batteries used for radio purposes, when first purchased often have a specific gravity of 1,300. This high value is rarely maintained. It is, however, inadvisable to let the gravity get too low, as the battery is apt to lose capacity. It is much better to charge frequently so that the battery will be at or near the maximum capacity most of the time. Where the drain on the battery is more or less uniform the proper thing to do is to have regular periods for charging and adhere closely to these periods. The battery whose specific gravity is around 1,275 may be considered in good condition.

3.—There is little doubt but that alternating current is best to use in charging batteries, but it must be remembered that it is first necessary to rectify this current by some means so that the actual current passing through the battery is not alternating, but direct.

Question for May

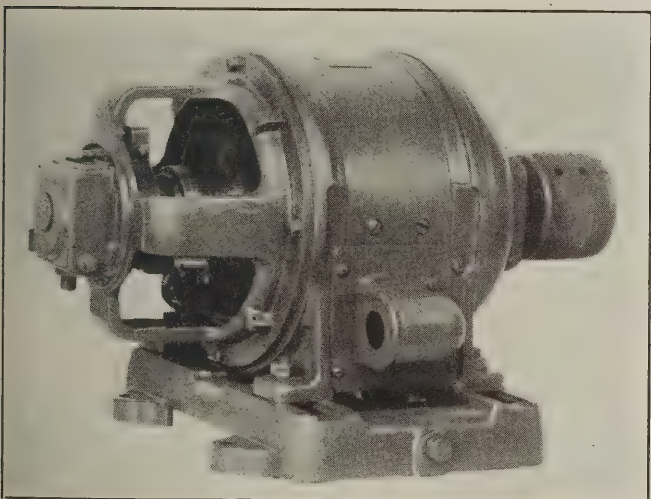
1. *How can an electrolytic rectifier be constructed?*



General Purpose Motors

With the marketing of a new type of direct current motor and a redesigned type of alternating current motor, the General Electric Company is now manufacturing a completely revised line of "general purpose" motors. This line includes all standard speeds and horsepower ratings for use on any standard circuit.

Distinct advantages are claimed as a result of this re-

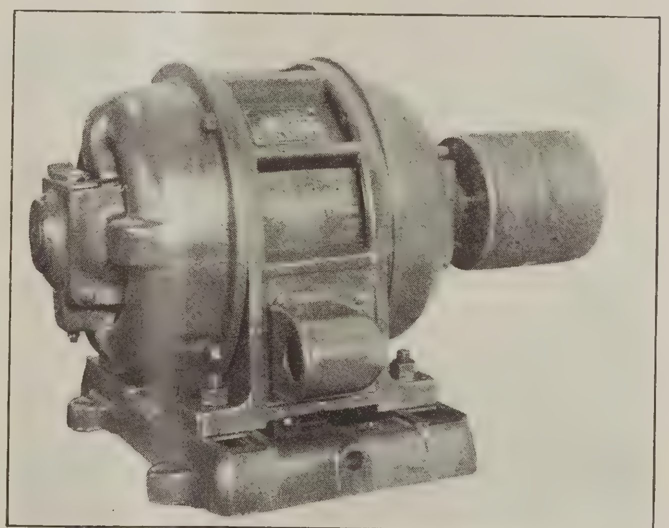


Type BD-45—2 Pole, 3 Hp.—1750 R. P. M.—230 Volt Shunt Wound Motor

vision. The use of the steel shell, babbitted bearing, first adopted on KT-300 motors, has been extended to cover all general purpose motors. Although the use of sleeve bearings is advocated, provision has also been made to furnish many of the standard types of general purpose motors with ball bearings for those who prefer this type. A further advantage resulting from the revision is the fact that some of the smaller direct and alternating current motors, rating for rating, are mechanically interchangeable.

The redesigned alternating current motors supersede the KT-300 line and are designated as KT-500. These motors are for use on polyphase circuits and are made in two types of rotor construction, the squirrel cage and the wound rotor design. Standard power ratings range from 5 to 200 horsepower. The squirrel cage rotor motors bear the designation KT-500, and the wound rotor type, MT-500. All are of the skeleton frame type and include both horizontal and vertical machines. The horizontal motors are suitable for belt, gear or chain drive or for direct connection, and the vertical machines are mainly adapted for direct connection.

Improved bearing construction is the keynote of the redesign of the alternating current types. Details include larger shafts and bearings, larger oil rings with lower oil level and larger oil reservoir capacity. The oil ring is retained in its slot by a guard permanently attached under the bearing screw. Other improvements include the use of spring oil well covers and improved insulation in the small, closed slot frames. The improved insulation, now included as standard on smaller sizes, makes these motors suitable for operation in places where special atmospheric conditions are encountered. The redesign of bearing housings is expected to eliminate minor troubles from oil



Type KT—220-Volt Induction Motor

leakage and to reduce the maintenance cost and amount of attention required.

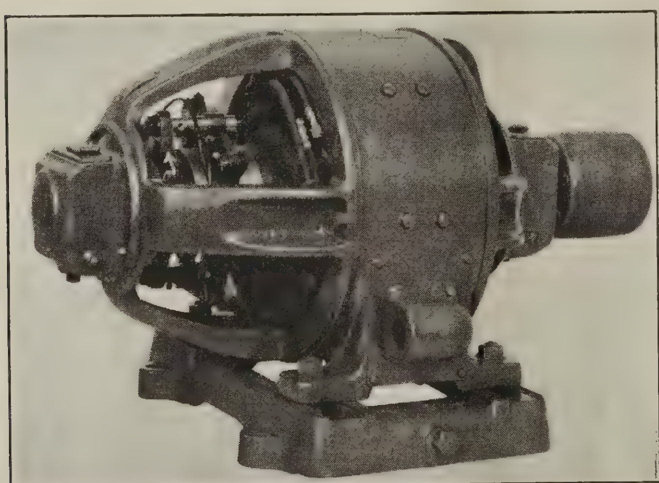
The new direct current motors include both constant and adjustable speed machines. The bi-polar type bears the designation BD and the four-pole motors are designated as Type CD. In view of the very flexible electrical and mechanical design, the older Types RC, RA, LC, RT,

C and, in some cases, RF motors, are now superseded by the new lines. Thus the same line runs from slow speed blower motors to high speed motors for driving pumps, including all intermediate types.

The BD and CD types range from ½ to 200 horsepower, the former being two-pole machines made in sizes from ½ to 3 horsepower, 1,750 r.p.m., and the latter, four and six pole, running from 3 to 200 horsepower. Speeds used are 1,750, 1,150 and 850 r.p.m. The motors are interchangeable as far as speed is concerned, and this feature also applies mechanically to some extent to the frames used in the BD line. These direct current motors are made for use on standard circuits of 115, 230 or 550 volts.

The outstanding improvements found in the new direct current line are mechanical. Steel shell, babbitted bearing linings are used except in cases where ball bearings are preferred. The popularity of the riveted frame construction for small ratings of alternating current motors led to the adoption of this type of frame in the new BD motors.

As a result of these changes, the standard lines of general purpose motors are much simplified. Alternating current motors include the KT, MT and SCR types, the SCR, KT-900 and MT-900 machines having been introduced during 1923. All KT motors utilize the squirrel cage rotor and are constant speed machines for use on polyphase circuits. The MT machines are also for use on polyphase circuits, are constant or adjustable-varying speed, and utilize the wound rotor. Single phase motors are covered by the SCR type, these being constant speed machines ranging from ½ to 10 horsepower. The new BD and CD motors comprise the complete direct current line.



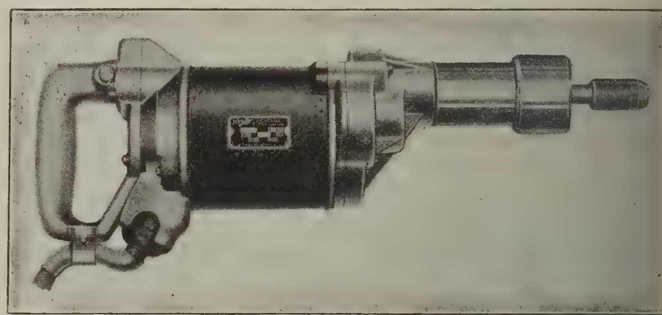
Type CD-65—230-Volt Shunt Wound Motor With Sliding Base and Pulley

An outstanding advantage of the standardization of these general purpose motors is the simplification of the renewal parts problem with specific reference to bearing linings manufactured for alternating current types, both single and multi-phase, thus enabling motor dealers to supply bearings for either alternating or direct current motors from the same stock. Most of the bearing linings, also, are interchangeable in any given type of motor, a total of approximately 2,500 ratings listed, utilizing not more than 23 different bearings. As a result, large users of motors are enabled to simplify the ordering and stocking of new bearings. This simplification promotes prompter service to users and enables both dealer and user to stock extra bearing linings in less space and more economically than heretofore.

Electric Friction Head Screw Driver

An electric screw driver, the driving head of which is equipped with a disc type friction clutch, which is regulated automatically by pressure applied by the operator, has been placed on the market by the Hisey-Wolf Machine Company, Cincinnati, Ohio.

It is equipped with ball bearings throughout and designed with the company's universal motor for operation on direct current, or single phase alternating current of the same voltage, and for any frequency from 25 to 60 cycles. The quick-cable external connector is a feature which permits cable repairs and renewals without dismantling the machine. The switch is fitted to the handle grip. The clutch casing is of convenient size and serves as an end grip when the work requires. The screw slot finding attachment, which may be secured with the machine, is intended to prevent the driving bit from slipping out of the screw slot and marring the surface of the work. These are made in three sizes with bits 5/16 in., ⅜ in. and 7/16 in. diameter. Two screw driving bits are furnished with the machine.



Friction Head Screw Driver Fitted with a Slot Finding Attachment

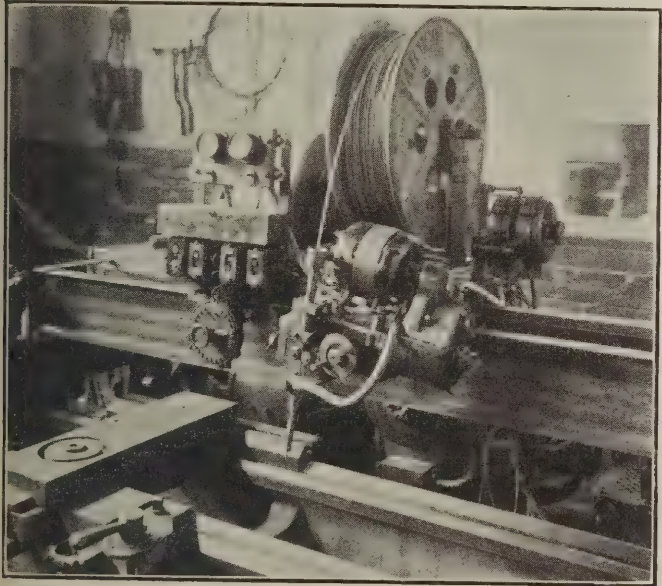
The capacity of the machine is for driving screws up to No. 14, 2½ in. long, in soft or solid wood. When suitable lead holes are provided, larger wood and lag screws up to 5/16 in. in diameter by 4 in. in length can be driven. These machines can also be used for setting up nuts to ⅜ in. in metal and wood. They are 15½ in. long and 3¾ in. in outside diameter. The no load speed of the spindle is 525 r.p.m. The net weight is 9½ lb.

Automatic Arc Welding Travel Carriage

For the purpose of simplifying the welding process in production work where similar welds are made repeatedly on similar articles, a travel carriage has been developed for the automatic arc welding of straight seams. This carriage is a self-contained unit made by the General Electric Company. It consists of an automatic welding head, necessary control, travel motor and wire reel support, all mounted on a suitable framework and provided with wheels for rolling along a track. The welding head and control are mounted on the apron of the carriage and feed

the electrode wire from a reel to the arc. This reel is carried by supports attached to the carriage frame.

In operation, the travel carriage is so controlled electrically by means of push buttons that, once the work is set up ready for welding, the operator may throw the system to automatic position, thus confining the control of both welding head and travel motor to one push button. Control of the welding head and travel motor is so interlocked that, when the starting button is pushed, the arc is automatically established simultaneously with the starting of the travel motor. Should the arc fail for any reason, the travel motor will stop without overtravel. The arc will re-establish itself and the travel motor will re-start, all without attention from the operator, thus insuring a continuously welding seam. An adjustable time limit switch stops the motor at the end of the weld and the carriage is returned to the starting position either by hand, or electrically by manipulating the push buttons. The carriage can be provided with an oscillator to be used when welding heavy plate.



The Travel Carriage in Place for Building Up Worn Lathe Ways

The approximate dimensions are: length, 3 ft. 6 in.; width, from front of apron to back of carriage, 2 ft. 7 in.; height above track, 2 ft. 6 in., and weight, 800 pounds. Some applications for such a device are: welding longitudinal seams in sheet steel tanks such as gasoline tanks, range boilers and transformer tanks, and in building up locomotive guide rods and other worn flat surfaces of all kinds.

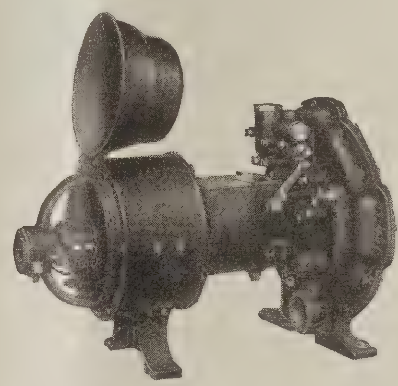
Some of the advantages claimed by the General Electric Company for the automatic process of arc welding are economy of electrical energy; increased speed; superior quality as regards strength, solidity, ductility, uniformity and continuity; the production of certain welds impossible by hand welding; general elimination of the personal element, etc.

Turbo-Generator Lighting Sets

Two new types of turbo generator units have been placed on the market by the Moon Manufacturing Company, Chicago, Ill. One of these is a 1½ kw. unit and the other has a rating of 4 kw. ventilated and 3 kw. closed. Both machines are designed for lighting service on construction work, wreckers, small engine houses, tug boats, etc. Similar units will soon be offered by this company for the lighting of coaches for suburban and branch line service.

The smaller machine known as type 4-C was designed to meet the requirement for a slightly larger machine than the 1 kw. type 4-A and 4-B made by this company. All parts of the generator with the exception of the armature and field coils are interchangeable with those on the 4-A machine. The 4-C type is wound for 110 or 220 volts and runs at a speed of 3,100 r.p.m.

The larger machine known as type 6 runs at 3,600 r.p.m. and is wound for 32, 110 or 220 volts. The turbine is provided with 4 primary nozzles so located that the action of the steam upon the rotor produces a balancing effect, relieving the bearings from stress. The shaft is mounted on ball bearings in dust and watertight compartments and oiled by a method which applies a spray of oil to the bearing. The governing mechanism is located in a sealed compartment in the body of the machine, entirely out of the steam. The governing valve is located at the top of the turbine body and constitutes a separate unit, easily removed or replaced. The rotor or turbine wheel is constructed of steel with bronze mounting, the vane ring being a separate part mounted on the rotor. The generator frame is made of wrought steel. The armature which is form wound is built on a sleeve that may be removed from the driving shaft. The generator is provided with a hinged cover that effectively seals the generator from water, dust and gas. The weight of the machine complete is 388 lb.



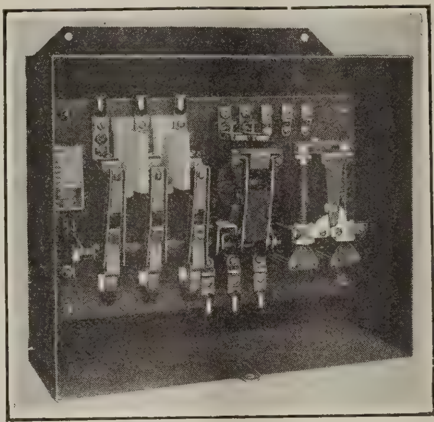
Moon 4 kw. Turbo-Generator Set

Non-Renewable Cartridge Fuses

A new line of non-renewable cartridge fuses has been placed on the market by the Trico Fuse Manufacturing Company, Milwaukee, Wis., manufacturers of Trico powder-packed, renewable fuses. The new line, which is built in all standard sizes, 0 to 600 amp., and fully approved in both the 250 and 600 voltages, is known as the Trico "Kantark" non-renewable fuse. The fuses are made with black tubes and the caps on ferrule types are crimped solidly to the tube and indented on the edge to prevent turning. The amperage capacity is stamped plainly on the caps and the label is wrapped completely around the fuse. The terminals of the knife blade fuses are held in positive alinement.

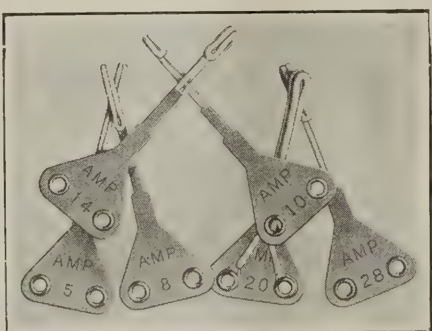
Changes in Monitor Thermaload Starters

Thermaload starters, manufactured by the Monitor Controller Company, Baltimore, Maryland, are now being built with standard Monitor side-arm contactors instead of the special contactor previously employed. Hairpin shaped thermal elements are also being supplied, instead of the coiled elements previously used. These new thermal elements are interchangeable with the coiled elements previously used and are all of the same size permitting the horsepower rating of a starter to be quickly changed, as in the past, by inserting thermal elements of the proper rating.



The Monitor Thermoload Starter

The Monitor Thermaload Starter is intended for starting small induction motors, both single-phase and polyphase. Its essential parts consist of a side-arm contactor and a thermal relay for protecting the motor against overloads. The starter protects the motor against light overloads dangerously prolonged and also permits the motor carry heavy overloads momentarily. A full voltage, full-current and full-torque start is obtained yet the motor is fully protected against undue heating both when starting and when running. The starter also protects polyphase motors from damage due to single-phase operation, that is overloads resulting from the accidental disconnection of one of the phases.



New Type of Thermal Element Used

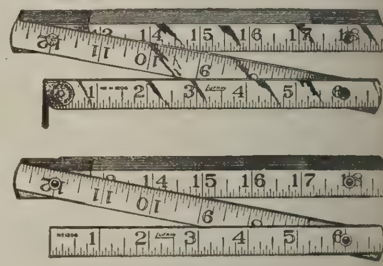
The starter is made in the automatic reset type for use with push-button or other forms of momentary-contact pilot-circuit control and of the manually reset type for use with float switches, and pressure governors, and other forms of maintained-contact pilot-circuit control. Low-voltage protection is an inherent characteristic of the automatically reset type of starter. For installation in places where inflammable gases, dust-laden air or other conditions necessitate precautions against arcing, the starters can be furnished with all arcing contacts immersed in oil.

One of the outstanding advantages of the starter is that the same starter may be used to start any small alternating-current motor operating on the same voltage and frequency as that for which the starter is rated. The change in ampere rating of a starter is effected simply by inserting thermal elements of the proper rating.

The thermal relay operates on the thermal expansion principle. The heat produced by the thermal elements under overload causes a liquid confined in tubular receptacles to expand and to elongate two expansion units. These expansion units operate an arm containing two contacts which control the operating circuit of the contactor. Two contacts are used to make the relay chatter proof. The liquid used is carbon tetra-chloride, which is used extensively for fire extinguishing purposes.

A Folding Rule of Aluminum

Recognizing the value of aluminum where a metal is desired that is both light in weight and unaffected by exposure to deteriorating or disfiguring influences, the Lufkin Rule Company, Saginaw, Mich., has begun the manufacture of rules of this material. These rules are 9/16 in. wide and have 6 in. folds. Like the familiar folding rules of wood they are made in 3-ft., 4-ft., 5-ft. and 6-ft. lengths. At the joints, where the most severe strain on a rule is encountered, solid brass joints are provided and at the same time these joints are given a spring effect which makes them firm enough to hold the rule properly up to its work when extended. The rule surface is in the natural color with sunken black markings which show up distinctly and are proof against becoming illegible by rusting or wear.



The Hook and Plain Rules

To meet the demand that initially led to the development of a wood rule having a folding end hook, such an attachment has also been provided in the aluminum rules. The device consists of a small brass hook fitted at one end of the rule and so attached that it easily folds up and remains flush with the edge of the rule when not in use. The zero point falls at the inside of the hook when open and at the extreme end of the hook, as in other rules, when closed.

Improved Hand Starting Compensators

Hand starting compensators manufactured by the General Electric Company and bearing the type designation CR-1034 have been redesigned. These compensators are for use on alternating current circuits for starting squirrel cage induction motors.

Temperature overload relays have been incorporated in the compensator, replacing dashpot overload relays. In one of the sizes multiple rated auto-transformer coils are used instead of the single rated variety. The redesigned compensators also include an improved push-button mechanism, containing an attachment for resetting the temperature overload relay.

Closer overload protection is expected with the newer type of relay. The multiple rated auto-transformer coils, where used, permit the use of one compensator for several horsepower ratings for a given voltage. The incorporation of the relay resetting function in the push button simplifies the operation of the device, making it unnecessary to open the compensator for this purpose.

General News Section

Chicago Fuse Manufacturing Company announces the removal of its New York office and warehouse to more spacious quarters at 71 Murray street.

The H. C. McNair Company, St. Paul, Minn., has been appointed district representative for the Elwell-Parker Electric Company, Cleveland, Ohio.

The Gould Coupler Company and the Gould Storage Battery Company, Inc., on April 21 moved their offices from 30 East Forty-second street to 250 Park avenue, New York City.

Western Electric Company, New York, announces the opening of a new electrical supply distributing house in Kansas City. The new building has a floor area of 44,000 square feet.

The Oliver Electric and Manufacturing Company has moved its Chicago offices from the McCormick Building to rooms 2140-42 Straus Building, 310 South Michigan Boulevard.

George C. Hayes, 225 Indiana Terminal Warehouse building, Indianapolis, Ind., has been appointed district engineer of the territory contiguous to Indianapolis for the Elwell-Parker Electric Company, Cleveland, Ohio.

R. W. Kinkead, former chief engineer of the welder division of the Lincoln Electric Company, Cleveland, Ohio, has been transferred to the sales department and now is regional director of sales. His headquarters are in the Ellicott Square building, Buffalo, N. Y.

The Interstate Commerce Commission has granted a petition of the Chicago & Northwestern for exemption from equipping with automatic train control devices the locomotives of its Sioux City division operating between Maple River junction and Carroll, Ia., 3½ miles.

Great Northern.—The electrification of the line from Tye, Wash., to Skykomish, a distance of 25 miles, has been authorized. Plans have not been completed and it has not been decided whether the company itself will do the work or whether it will be carried out under contract.

American Chain Company, Bridgeport, Conn., announces the appointment of William C. Wolfe as district sales manager, weld and weldless division, with headquarters at Room 690, 209 South La Salle street, Chicago. Mr. Wolfe succeeded George C. Isbester, resigned.

The Pennsylvania Railroad has contracted with the Public Service Corporation of New Jersey for a supply of electric power, varying in amount according to actual need, designed to supplement the power which the railroad company now receives at New York from its power plant in Long Island City. The new supply of power is intended solely to meet the needs of the existing electrified section of the Pennsylvania Railroad between Pennsylvania Station in New York City and Manhattan Transfer and the Long Island Railroad.

The Page Steel & Wire Company announces the appointment of J. J. Flaherty to direct sales of Armco, High Carbon and Low Carbon welding rod wire. Mr. Flaherty, who was formerly in charge of welding for the Boston Elevated Railways, will have headquarters at Bridgeport, Conn.

Benjamin Electric Manufacturing Company, Chicago, Ill., announces the appointment of Wallace J. Goodrich to the position of manager of the railroad department. Mr. Goodrich has represented the company for the past six years in Chicago. His headquarters will be at 128 Sangamon street.

The Interstate Commerce Commission has authorized the Chicago, Indianapolis & Louisville to install automatic train control upon its air line between Hammond and Monon, Ind., in lieu of the installation required in the commission's order of June 13, 1922, but has denied the company's petition that the order of January 14, 1924, requiring an installation upon another portion of its line be vacated.

The Union Pacific has placed orders with the Union Switch & Signal Company for the materials necessary to equip the road between Sidney, Neb., and North Platte, 124 miles, double track, with the Union two-speed continuous inductive automatic train control system. This is the third division on which the Union Pacific is installing this system of train control. A total of 31 locomotives will be equipped for operation in this territory.

Jenkins Brothers, New York, has purchased outright the good will and stock of the corporation of H. A. Rogers Co., 87 Walker street, New York, dealers in railway, mill, mining and contractors' supplies. This corporation has for many years been the sole agent in the United States for John Moncrieff, Ltd., Perth, Scotland, manufacturer of Moncrieff Scotch gage glasses, and this agency will be carried in future by Jenkins Brothers. The other specialties dealt in by the H. A. Rogers Co. will be closed out and discontinued. William A. Tucker, who has been connected with H. A. Rogers Co. since 1880, will in future be associated with Jenkins Brothers.

The extensive patent litigation which has been going on since 1911 between The Safety Car Heating & Lighting Company and the U. S. Light & Heat Corporation, and its predecessor, The United States Light & Heating Company, recently resulted in a judgment against the U. S. Light & Heat Corporation for over $500,000. The parties have agreed to settle this judgment by the sale to The Safety Car Heating & Lighting Company by the U. S. Light & Heat Corporation of all of its patents, ma-

chinery, equipment and inventory used in, or connected with carlighting. This sale does not include USL arc welders or the USL batteries. U. S. Light & Heat Corporation will therefore continue to manufacture and sell arc welders and a complete line of batteries, including train lighting batteries. The Safety Car Heating & Lighting Company will be in position to furnish USL type car lighting devices, repairs and replacements.

Progress in Automatic Train Control

The Union Pacific's action in proceeding to install automatic train control on a third locomotive division, applies to a section of road covered by the government's second order, that of July 18, 1924, the compulsory feature of which does not come into effect until February 1, 1926. The Atchison, Topeka & Santa Fe is another road on which the second order is already being carried out, the work now going on between Chicago and Chillicothe, Ill., 130 miles, being in territory designated by the order of 1924, not that of 1922. Nine roads have now completed the installations, including the equipment of locomotives, as called for by the commission's first order, namely: Chesapeake & Ohio; Chicago, Rock Island & Pacific; Chicago & Eastern Illinois; Southern Pacific; Galveston, Harrisburg & San Antonio; Atchison, Topeka & Santa Fe; Reading; Norfolk & Western; Oregon-Washington Railroad & Navigation Company.

Staten Island Tunnel

The plan of the Mayor of New York for a tunnel under the bay from Staten Island to Long Island, to be used for both passenger and freight traffic, has been thwarted by an act of the legislature, approved by Governor Smith on April 22, stipulating that the tunnel, if constructed, shall be for rapid transit purposes exclusively; that is, for passengers. The city has already expended large sums on plans and for preliminary operations, but the Governor, in a statement accompanying his approval of the law, says that the change now required will save $38,000,000 of the people's money. The city, says the Governor, may provide for passenger transportation, but provision for freight transportation is in the hands of the Port Authority; and the tunnel scheme of the city conflicts with the plans of the Port Authority. The Governor criticizes the scheme of the Mayor as tending to result in the expenditure of many millions for a freight tunnel when there is no assurance that any railroad company will be willing to make use of the tunnel.

Pennsylvania Railroad Apprentice School

With the completion of new and enlarged facilities, the scope of the Pennsylvania's apprentice school at Altoona, Pa., has been materially increased, so that approximately 400 apprentices are receiving the benefit of its courses of instruction. The school, which was temporarily discontinued in 1921, was reopened in January of the present year, but was confined to apprentices from the Altoona machine shop only. More room has since been provided by an extension of the building, and in addition to the machine shop boys, the school is now open to regular apprentices from the Juniata shop, the Altoona car shop, the South Altoona foundry, and the Middle Division.

School sessions are held after working hours from 7:00 to 8:30, and 8:30 to 10:00 p. m. on Monday, Tuesday and Wednesday, and from 4:30 to 6:00, 7:00 to 8:30, and 8:30 to 10:00 p. m. on Thursday and Friday, the boys being arranged in sections so that each will be given three hours' school work each week during the period of his apprenticeship. The curriculum provides for mechanical drawing, mathematics and mechanics bearing on shop work, study of materials of construction which deal with the manufacture of iron and steel, and characteristics of different kinds of steel as used in the shop. The courses are adapted for the apprentices in the trades of the different crafts, such as machinists, boilermakers, pipe fitters, and electricians.

Association of Railway Electrical Engineers

At an executive committee meeting of the Association of Railway Electrical Engineers held in Chicago, April 18, it was decided that no semi-annual meeting of the association would be held this year. This step was taken on account of the fact that the mechanical section of the American Railway Association will not hold its annual convention in Atlantic City this year.

The annual convention of the electrical engineers will be held at the Hotel Sherman, October 27-30, inclusive. It was found necessary to select new quarters, due to the fact that the association has outgrown the exhibit space at the LaSalle Hotel. A new addition has been built to the Hotel Sherman, which gives considerably more space with all of the exhibits in one room, and has a further advantage of permitting a greater number of exhibits than heretofore.

N. Y. C. Awards Train Control Contract

The New York Central has awarded a contract to the Miller Train Control Corporation for the installation of its intermittent inductive train control system, including the plain automatic stop, cab reset and forestalling privilege, permissible under Interstate Commerce Commission's amended order of July 18, 1924, and approved on Chicago & Eastern Illinois installation. The initial installation will be on the four-track line of the N. Y. C.'s Erie division from Cleveland to Painesville, Ohio—66 miles of track—with equipment for five passenger and five freight locomotives.

Personals

H. M. Van Gelder has been appointed electrical engineer of the Department of City Transit, Philadelphia, Pa., to take charge of the design and to supervise the installation of electrical equipment for the new Broad street subway system. Up to 1920, Mr. Van Gelder was with the Westinghouse, Church, Kerr & Company, holding the position of electrical engineer and then managing engineer. Since that time, he has been engaged on various steam railroad electrification projects; recently on electrification studies for the Canadian Pacific.

L. E. Lynde, of the heavy traction division of the Westinghouse Electric & Manufacturing Company of East Pittsburgh, has been transferred to the transportation division of the New York office. Mr. Lynde graduated from the University of New Hampshire after completing

a course in electrical engineering. He came to the Westinghouse Company in 1920, where after taking a student course, he entered the heavy traction division. In that department he has been closely associated with all of the important steam railway electrifications since he entered the sales work of the company.

Don C. Wilson has been recently appointed general sales manager of the Edison Storage Battery Company, with headquarters at Orange, N. J. Mr. Wilson was educated in the public schools of Broken Bow, Nebr., and the Nebraska State University, completing his course in electrical engineering in 1907, after which he engaged in electrical work with the Stone & Webster Construction Company at Seattle; the United States Navy Yard, Brennerton; the Pacific Gas & Electric Company, Los Angeles; the Independent Telephone Company, Omaha; the Union Pacific Railroad, Omaha; the Central of Georgia at Savannah, and the Delco Light Company of Chattanooga. In 1920 he became assistant sales manager for the Edison Storage Battery Company in charge of the railway department, which position he held at the time of his recent appointment.

D. C. Wilson

Hugh W. Pinkerton, assistant engineer in the electrical department of the New York Central at New York, has been appointed to the position of assistant electrical engineer with the Cleveland Union Terminal Company at Cleveland, effective May 1.

Hugh W. Pinkerton

Mr. Pinkerton was educated in Scotland, having graduated in 1899 from the Royal Technical College of Glasgow, upon the completion of a course in electrical engineering. Early in his career he was connected with electrical railways, his first experience being at Hartlepool, England. Later he held a position of electrical engineer for the city of Birmingham Tramways Company of Birmingham, England, and in this capacity was responsible for putting into service the first electric car operated in that city. This company was once controlled by the late James Ross of Montreal, Canada. In 1906 Mr. Pinkerton came with the New York Central and has been closely associated with all of the electrification work done by this road. In assuming his duties at Cleveland, Mr. Pinkerton will have direct charge of all of the electrical activities connected with the Union Terminal, representing Edwin A. Katte, who is consulting electrical engineer for the project.

M. Kennedy, formerly section manager in the light traction division of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, has been transferred to the transportation division of the Philadelphia office. Mr. Kennedy graduated from Washington University in 1916 after completing a course in electrical engineering. He entered the service of the Westinghouse Company as a graduate student and later was connected with the sub-station section of the power department. In 1920 he was transferred to the railway department in charge of light traction negotiation work for foreign fields, and later he was made section manager in the department, which position he held until his recent transfer to Philadelphia.

Sir Thomas Octavius Callender, manager-director of Callender's Cable & Construction Co., Ltd., London, England, the largest manufacturers in the world of paper insulated cables, and a director in several other corporations and prominent in the development of the electrical industry in Great Britain will soon visit the United States. Sir Thomas entered his father's business in 1873 in connection with the paving of streets with asphalt. Experiments carried out by himself and his brothers led to the discovery of the insulating product known as vulcanized bitumen. In 1882 a company was formed to manufacture insulated wires and cables by this process and upon the development of this business and the expansion of the electrical industry the company was reorganized in 1898 to its present name. Manufacturing arrangements are being completed in the United States for the Okonite Callender Cable Co., Inc., a subsidiary of the Okonite Company, New York, to supply the electrical industry with impregnated paper cables made under the Callender patents. A new plant at Paterson, N. J., equipped with specially designed Callender machinery embodying the latest practices of this company and Europe will be ready for operation about July 1. A completely equipped electrical research laboratory will be maintained which will work in conjunction with the Callender research laboratory.

Sir Thomas Callender

Homer E. Gannett, general electrical foreman, Chicago, Burlington & Quincy, has been promoted to assistant engineer to fill the position formerly held by T. W. Wigton. Mr. Gannett was born in Chicago, on October 19, 1892, and was first employed by the Commonwealth Edison Company as an electrician in 1909. He attended night school at Lewis Institute in 1911, and on September

14, 1914, left the Edison service to accept a position as road electrician on the Chicago, Burlington & Quincy. Two years later he was appointed electrical foreman, which position he held until 1918 when he worked as a valuation inspector for about a year. He was promoted to general electrical foreman in 1919 in which capacity he served until his recent promotion to assistant engineer on March 15.

W. H. East, assistant electrical engineer of the Chicago, Burlington & Quincy, has left to accept a position as sales engineer in the railway sales department of the Central Electric Company, Chicago, effective March 15, 1925.

Theron W. Wigton, formerly assistant engineer, electrical department, Chicago, Burlington & Quincy, has been promoted to assistant electrical engineer, succeeding W. H. East. Mr. Wigton was born on December 23, 1887, at Waukon, Ia., and after graduating from high school, he studied electrical engineering with the International Correspondence Schools while doing electrical work. On June 13, 1913, he entered the service of the Chicago, Burlington & Quincy as an electrician and served in consecutive capacities in the electrical department until his promotion on March 15, 1925, to assistant electrical engineer.

Charles R. Stover, formerly in the sales department of the National Lamp Works of the General Electric Company at Nela Park, Cleveland, Ohio, has been transferred to the Sunbeam Incandescent Lamp Division of the same company, as a railroad specialist, with headquarters in Chicago. He was born at Altoona, Pa., on August 7, 1887, and graduated from Pennsylvania State College in 1910. The following year he attended Massachusetts Institute of Technology, leaving the latter institution to enter the engineering department of the National Lamp Works, Nela Park, Cleveland, Ohio, on July 1, 1911. He was transferred to the commercial development department on September 1, 1913, remaining there until February 1, 1923, when he was transferred to the sales department with the same headquarters, in which position he continued until his recent transfer as previously noted.

E. A. Thurmond was appointed electrician in charge of car lighting at the Norfolk terminal coach yard of the Norfolk Southern Railroad at Norfolk, Va., on February 1. Mr. Thurmond has had quite a varied electrical experience. In 1912 he held a position as switchboard operator in Augusta, Ga., with the Augusta Aiken Railroad & Electric Corporation. This position he held for three years when he was promoted to chief operator. In 1917 he entered the service of the Phosphate Mining Company at Nichols, Fla., to install a new power plant and do general electrical repair work. A year later he accepted a position in charge of the electrical repair shop of the Pery Pehle Mining Company at Brewster, Fla. In 1920 Mr. Thurmond returned to the Augusta Aiken Railroad & Electric Corporation as general power plant repair man, and in this connection installed the first automatic substation in the south. Two years later he accepted a position with the Florida East Coast Railroad at St. Augustine as general maintainer, including car lighting, which position he held until his recent appointment with the Norfolk Southern Railroad.

Mr. Thurmond has made a special study of car lighting and may be considered an expert in car lighting and power plant matters.

Trade Publications

Viele, Blackwell & Buck, New York, has recently issued a booklet illustrating and describing Weldless Steel Poles. The poles are of one piece seamless tubular construction.

Crouse-Hinds Company, Syracuse, N. Y., is distributing a large illustrated folder showing the construction and use of "Arktite" circuit breaking plugs and receptacles which it manufactures.

Engbergs Electrical & Mechanical Works, St. Joseph, Mich., has recently issued its new catalogue, No. 105, entitled "Direct Current Generating Sets." The booklet contains 32 pages and is illustrated with numerous photographs of direct connected engine driven sets as well as various places where they have been installed.

Floor Operated Electric Hoists is the title of a large 60-page illustrated price list and catalog recently issued by the Shepard Electric Crane & Hoist Co., of Montour Falls, New York. The book contains descriptive matter pertaining to the various kinds of crane and hoisting equipment manufactured by the company. Numerous photographs are shown illustrating the application of the different kinds of apparatus in widely varying industries.

A 12-page booklet recently published by the General Electric Co., bearing the designation describes the new Type A welding electrode. Details are given on electrode construction and characteristics. Results of tests on welded cast iron specimens and deposited metal specimens are described, and oscillograms demonstrating arc stability are reproduced. Instructions for use of the electrode are supplied and specifications of the standard sizes given.

The Detroit Electric Furnace Company, Detroit, Mich., has just had issued a catalog, describing in detail, the advantages, performances and results obtained with their electric brass furnaces in the brass melting field. The outstanding features of economy, mechanical control and speed of production are all clearly enumerated and described. This booklet is known as the "Speedier Production—Better Brass" catalog and contains very important and specific information with many illustrations.

The Westinghouse Electric and Manufacturing Company has just completed the reprint of a paper on "The Development of the Electric Locomotive." This paper was originally presented before the meeting of the American Railway Association in Atlantic City in June, 1924. The paper contains twenty pages of descriptive matter pointing out the salient facts incident to electric locomotive progress. A valuable supplement to the paper is the two large charts compiled from electrical and mechanical characteristics of all a-c. and d-c. electric locomotives in operation in this country and abroad. These charts in themselves are unquestionably the most complete and most accurate compilation of this kind ever published, and will provide a ready reference to anyone interested in this type of motive power. Copies of this publication will be sent free upon request at the Department of Publicity of the Westinghouse Company.

Railway Electrical Engineer

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No June Convention

While in some respects it seems unfortunate that the semi-annual meeting of the association of Railway Electrical Engineers must be omitted this year, in a larger sense it may prove to be beneficial. The committees will not be required to submit progress reports of any kind to the association. Although this fact relieves the committees of a small part of their respective tasks, it is to be hoped that it will in no wise reduce the efficiency of the committees and that they will be in readiness to present complete reports full of useful information at the annual meeting of the organization which will be held in October. The next annual convention of the association will be a mile stone on the road of progress as it will mark the period when the association has outgrown the quarters that have housed it for so many conventions in the past. Although the June convention in the east will be missed this year, the mere fact that it is omitted makes it doubly important for each and every member of the association to be on hand when the gavel falls in the more spacious quarters of the Hotel Sherman in October.

Power for Train Control

As the matter of train control takes more definite form on the different railroads certain phases of this comparatively new development become more and more interesting. Some form of power for the operation of train control circuits is required on the locomotive in the majority of systems. Storage batteries have been considered for this purpose, but in all probability they will in the majority of instances, at least, only be adopted as a standby or reserve; from the present indications, it is practically certain that turbo-generator sets will be used for locomotive lighting and for train control as well. Needless to say the two applications mentioned are about as far apart electrically as they could possibly be. The lighting on the locomotive is important but the integrity of the train control equipment is much more so. Turbo-generators which have been designed exclusively for locomotive lighting are not likely to serve the needs of train control. If a single turbo-generator is to be used for lighting and train control the machine must be designed with this dual purpose in mind, and when this is done there is every reason to believe that satisfactory results will follow. Fortunately these facts have been taken into consideration with the result that the manufacturers have developed turbo-generators which will not only carry the lighting load of the locomotive but will give reliable service for the train control operation as well.

Court Modifies Train Control Order

For the first time the merits of the federal law requiring railroads to install automatic train control devices, have recently been made the subject of a judicial decision; and the course thus far pursued by the Interstate Commerce Commission is sustained except in the important detail that when the commission changed its mind in July, 1924, and allowed the use of a forestalling device on the locomotive, it thereby modified the conditions so radically that the two-year period allowed for compliance must be begun all over again; completion of the installation is not required until July, 1926. The extension of time is the salient point in the decision in the Delaware & Hudson suit, reported in another column; and evidently the law thus laid down will apply in favor of any road, that having planned to comply with the original order, desires for the purpose of saving expense, or to simplify the apparatus or practice, or for any reason, to introduce a forestalling device. The views of the three judges on the question of constitutionality, on the alleged inadequacy of the commission studies, and as to the expenditure by railways of large sums of money for experimental work, are quite sweeping; and if not changed by the higher court, will give a different aspect to some phases of the Interstate Commerce Commission's acts in the fields of railway safety.

Metropolitan Suburban Electrification

Two important electrification projects have been consummated during the past month in the territory adjacent to New York City. The first of these to go into operation was the extension of the Long Island Railroad between Jamaica and Babylon, a distance of 28 miles. The second is the beginning of electric operation of the Baltimore & Ohio suburban lines on Staten Island. Both of these installations are of the third rail type. The reason for the adoption of this type of electrification in both cases is obvious. With the Long Island it was merely an extension of existing facilities. The Staten Island equipment is patterned closely after the equipment used in the New York subways so that in the event of a tunnel being constructed between New York City and Staten

Island, which is more than a possibility, the same cars could be run through the tunnel into the subway lines.

Standardization, the Need of Electric Traction

At the annual meeting of the American Institute of Electrical Engineers, held on May 15 at the Engineering Societies Building, New York, the subject "Steam Railroad Electrification From the Executive Standpoint" was discussed in a manner quite apart from what might have been expected from the same kind of a meeting some time ago. The steam locomotive was not relegated to the scrap heap with undue haste. The advantages of electrification were pointed out and some of the requirements, particularly the need for standardization in the more basic parts of the work, were strongly emphasized. The so-called "battle of the systems" has apparently been dropped from such discussions for all time. The development of large connected power systems and their relation to electrification was also brought out. The interest manifested in the meeting was clearly reflected in the fact that every seat in the large hall was taken and many were standing, and this in spite of the fact that an exceptionally well attended meeting of the New York Railroad Club took place on the same evening.

The key note of the speakers as directed toward electrification was the need of standardization as a means of preventing heavy losses during the extensive developments of electric traction. It would be difficult to stress this particular point too much, for, if electrification is to progress, it is plain that it cannot be through scattered and dissimilar systems and voltages; some of the fundamental and basic construction can be and should be standardized. For example, it should not be an impossible thing to standardize trolley construction, kind of current and voltage used. Recent designs of electric locomotives have shown that it is quite practical to use an alternating current trolley with direct current motors by means of intermediate machinery. That some system of trolley construction and voltage be adopted as standard is of utmost importance as otherwise enormous economic losses will result from unrelated systems as electrification advances. Fortunately the manufacturing companies have seen the light and there are excellent prospects that those most deeply interested in the matter will be able to bring about some preliminary steps of standardization. With this once accomplished and some system of interconnected power made available, real progress in steam railroad electrification will be assured.

Car Lighting Belt Life

Expressions of opinion concerning the best kind of belting for car lighting purposes seem to vary with the locality. Some users will declare that a certain kind of belt is no good and others will be equally emphatic in stating that that particular kind of belt is the best kind manufactured. Local conditions have something to do with this variation in opinion; that is, temperature and other service conditions affect the belts, but for the most part it is probably due to the manner in which the belt is used and the kind of attention it receives.

If belt fasteners are not properly applied, if belt ends are not cut square, or if too great a belt tension is used, the belt will be lost regardless of its quality. Practically all belts will eventually crack at the fastener, but the belt need not be lost if it is watched. If the belt has stretched a little the ends can be cut off and refastened, or if necessary a short piece may be inserted in the belt.

Another factor of equal importance, which is often given insufficient attention, is alignment. If a generator is out of line it is likely that the belt will climb over on the pulley flange and wear badly, and even though it does not wear on the flange, the belt, and the belt fasteners are subject to uneven strains.

It is probably true that if all equipment was kept in first-class condition the best belt would be none too good and there would be much less difference of opinion concerning belt quality. In the last analysis, belt costs are the governing factor in the selection of a belt and if it is not possible to keep equipment in good condition —that is, if belts must be lost due to faults in the equipment—then a cheaper belt may give the lowest operating cost. This is a fact, however, which must be used with caution. If the bars are let down to permit a cheaper product into the field, it is necessary that rigid specifications be laid down, so that the principal characteristic of the belt will not be cheapness. A poor belt is not worth applying, whether or not the equipment is in good shape.

New Books

"Mechanical World" Electrical Pocketbook, 1925 edition, 386 pages, illustrations and diagrams, 4¼ in. by 6¾ in., bound in cloth. Published by Emmott & Company, Ltd., London, England. Price $.45.

This little book is of English origin and deals mostly with English practices. Among the new features found in the present edition is a section dealing with primary cells in which concise descriptive principles of the various types are given. A lengthy section has been introduced describing up-to-date methods of testing generators, motors and line are of vital importance and it is only by giving close attention to the details as pointed out by the author in this book, that reliable service is secured.

Mechanical Design of Overhead Electrical Transmission Lines.—By Edgar T. Painton, 274 pages, illustrations, diagrams, 5¾ in. by 8½ in., bound in cloth. Published by D. Van Nostrand Company, New York.

The mechanical side of the design of transmission lines is of equal importance with the design of the electrical characteristics. Mechanical strength of support, insulators and line are of vital importance to uninterrupted service and it is only by giving close attention to the details as pointed out by the author in this book, that reliable service is secured.

The tensile strength of conductors is first taken up and considerable space is devoted to sag and stress problems.

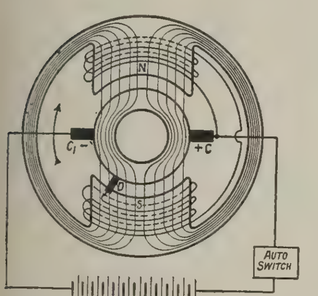
A large portion of the book treats of supports of various types, both wood and structural steel, as well as steel poles of special construction. One chapter deals entirely with the subject of insulators. The latter part of the book is devoted to constructional details.

Throughout the entire book numerous illustrations and diagrams are given and this is particularly true in the section concerned with the constructional details. Although the book has been written primarily for the designer and consulting engineer, its practical material makes it helpful to the constructor and operator as well.

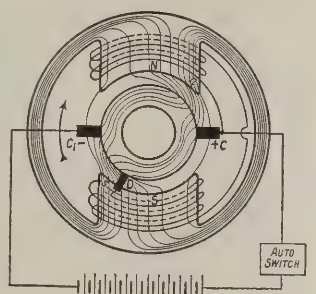
English Practice of Train Lighting

Details of the Rotax Leitner System as Used on Several Railways in Great Britain

MOST of the car lighting articles which have been published in these columns have been concerned with practices which exist in the United States. It would be a mistake, however, to imagine that cars in other countries are not illuminated by electric systems. It is true that the systems used differ in some respects from those in America, and for this reason, if for no other, it is interesting to study some of the practices which are in vogue in Great Britain and other foreign countries.



Uniform Main Field Flux at Low Speed and No External Load



Distorted Main Field at Higher Speed and External Load

The material contained in the following paragraphs was taken from "The Railway Engineer," a British publication, and the system of car lighting described is one of several which are used in Great Britain.

There are several well-known systems of electric train lighting available, among them being the Rotax-Leitner system, which has been installed on the Great Western and other railways in England, also on certain French lines, and others abroad. Many improvements have been embodied in the system since its inception in 1903, each being the result of actual experience gained in train-lighting service. A feature of the system is that the voltage of the lamps, also the charging of the battery, are both under control, so that the requirements of any particular service can be met in a ready and simple fashion. The complete lighting equipment comprises the dynamo, auto-switch, regulator and battery, with a main switch, operated either by hand or electromagnetically, for controlling the lights.

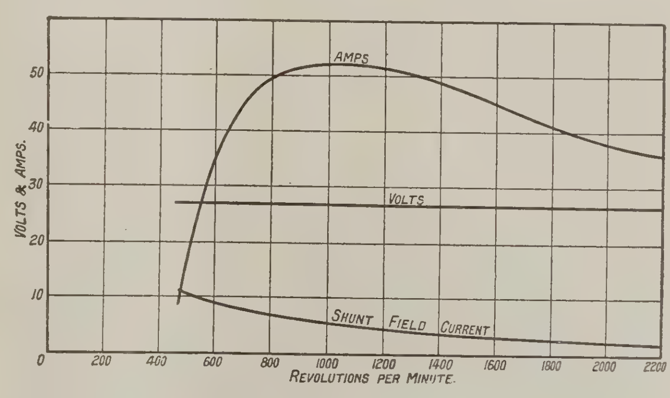
The Dynamo

The dynamo is of the variable speed pattern, inherently self-regulating, and giving approximately constant current over a very large speed range. It is a direct-current, four-pole machine of simple construction, and is shunt wound. Instead, however, of the shunt field being connected directly across the main brushes, as in an ordinary shunt dynamo, one end only of the field is so connected, while the other end is connected to an auxiliary or third brush, situated, electrically, between the main brushes. The field winding, as shown on the diagram, is connected between the positive main brush C, and a brush called the demagnetizing or auxiliary brush D, the latter brush being placed between the positive and negative main brushes, and in advance of the positive main brush C in the direction of rotation of the armature.

As the speed of the generator increases, the voltage also increases and causes a charging current to flow through the armature windings into the battery. As this charging current increases, the cross magnetic field produced in the armature, denoted by N and S on the armature in the right-hand diagram, distorts the main magnetic field, so that instead of the magnetism being evenly distributed under the pole pieces it is more dense in the pole tips marked n and s, as indicated in the right-hand diagram.

It will thus be seen that the armature coils no longer generate approximately equal voltages at the different positions under the pole pieces, although the voltage at the main brushes C and C_1 remains approximately constant, the dynamo being now connected in parallel with a battery. The greater part of the voltage at the main brushes is generated by the armature coils which are situated between the auxiliary brush D and the negative main brush C, while the positive main brush C and the auxiliary brush D, across which the field is connected, only a small part of the total voltage is generated. The field windings, therefore, are excited by a lower voltage than in the first instance, with the result that the main magnetic field is weakened. The magnetic distortion takes place very gradually with increase in speed and load so that the output of the generator remains practically constant over an enormous speed range.

A weak auxiliary, separately excited, winding is also provided on the poles of the dynamo. This is energized when the lamp switch is put "on," and serves to ensure the dynamo exciting at very low speeds. It is so effective that in most cases the dynamo "cuts in," when the lamps are "on," before the train has left the platform on starting its journey. The dynamo is mounted underneath the coach, and is suspended either from the body underframe or the truck. It is driven by either a belt or chain from a pulley or sprocket wheel fixed to one of the coach axles.



Characteristic Curves of the D. S. 6 Dynamo; a Widely Used Type

In order to charge the battery, it is essential that the polarity of the dynamo shall be constant, irrespective of the direction of rotation of the armature. To ensure this, a simple form of brush rocker is used to enable the main

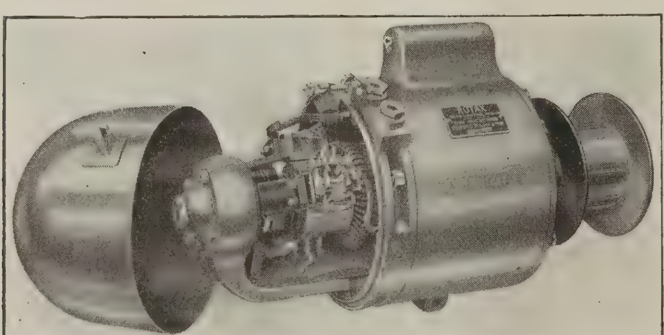
brushes to be rotated through rather more than the angle of "reversal" and the auxiliary brush through the angle of "lead." The rockers are mounted on substantial ball races, so that the friction of the Battersea carbon brushes on the commutator is more than sufficient to perform this operation. Adjustable stops are provided to limit the amount of movement of the rockers and admit a suitable "lead" being given in either direction of rotation. The armature runs on massive ball bearings, and the dynamo, being of simple and robust construction, and both dust-proof and water-tight, requires a minimum of attention in service.

Battery Charging Cut-out or Auto-Switch

In common with all other systems of electric lighting for trains, a means has to be provided for connecting and disconnecting the dynamo to the battery. This is accomplished in the Rotax-Leitner system by means of an electro-magnetically-operated auto-switch or cut-out, which automatically closes or opens the circuit between the dynamo and battery according to whether the voltage of the dynamo is greater or less than that of the battery.

Automatic Voltage Regulator

The regulator maintains a constant voltage on the lamps, and prevents overcharge of the battery. It works independently of dynamo speed and takes cognizance of electrical conditions only. It is controlled by an accurate contact voltmeter, or voltage balance, of the type in which the pull of a solenoid is balanced against that of an adjustable spring, at the desired lamp voltage. When the voltage increases above the normal, a contact is made at one end of the balance beam, and when the voltage drops below normal a contact is made at the other end. These contacts operate either of two relays, which supply current to a reversible motor, which in turn moves a rotatable contact arm, fitted with copper-morganite brushes, making contact on three rows of rheostat contacts. The outer row of rheostat contacts is in series with the lamps, the intermediate row is in series with the voltage balance itself, and

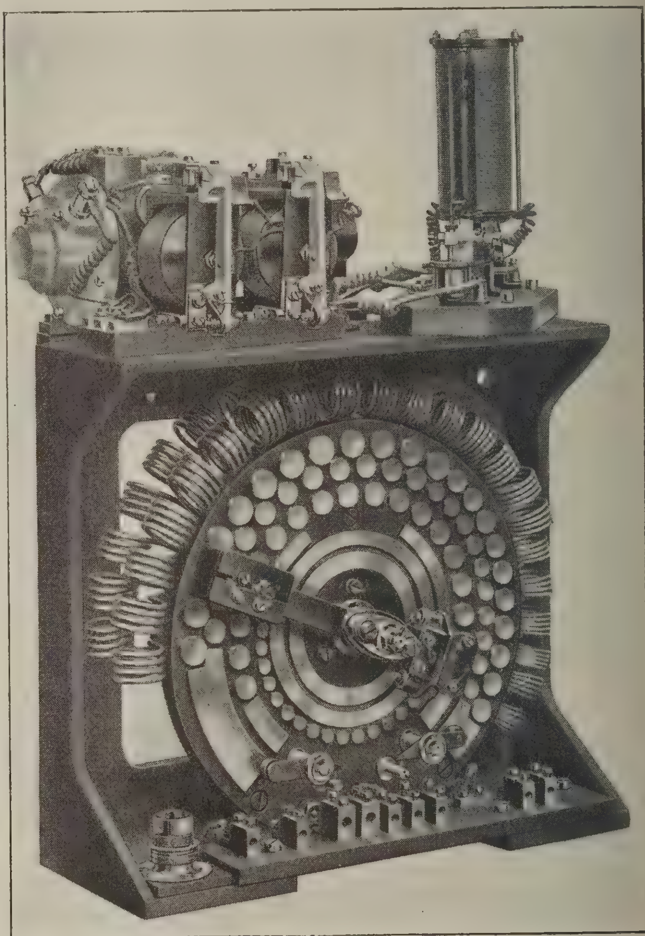


Rotax D. S. Type Train Lighting Dynamo with End Cover Removed Showing Commutator and Brush Gear

the inner row is in series with the field windings of the dynamo.

When the lamps are "off" and the dynamo is charging the battery, the voltage balance is connected across the battery; if the lamps are "on," it is connected across the lamp circuit. In the first instance, should the voltage of the battery rise, the voltage balance causes the rotatable contact arm to put resistance into the field circuit of the dynamo, thus reducing the amount of current going into the battery. At the same time, resistance is also introduced into the circuit of the voltage balance. This latter resistance, called the progressive resistance, increases the voltage, step by step, at which the beam of the voltage balance is in equilibrium.

This operation is repeated until the battery is fully charged—that is, until a voltage of about 34 is reached on a 12-cell lead-acid-lead battery—and the dynamo current has been gradually reduced until floating conditions are produced. It will be seen that the battery is thus charged under ideal conditions, and no overcharge occurs, so that the life of the battery is greatly prolonged, and the cost



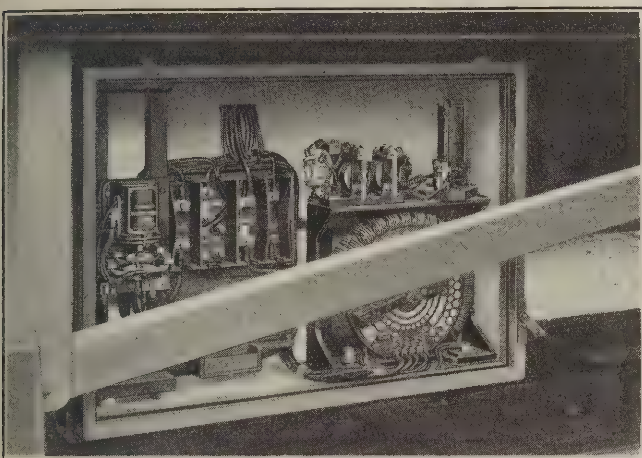
Automatic Regulator for Lamp Voltage, Dynamo Shunt Field Control and Battery Charging

of maintenance reduced to a minimum, both in replacements and "washing out."

In the second instance, when the lamps are "on" and the battery is being charged, the progressive resistance in series with the voltage balance is short-circuited, so that the voltage balance coil is in the same position electrically as a lamp. As the battery voltage rises, the voltage balance causes resistance to be inserted into the lamp circuit, and incidentally into its own, thus keeping the voltage on the lamps approximately constant. At the same time that the voltage balance adds or subtracts resistance in the lamp circuit, it simultaneously adds or subtracts resistance in the field circuit of the dynamo. These resistances are so arranged that when the battery is fully charged, the output of the dynamo is practically equivalent to the current taken by the lamps, so that under these conditions the battery is again floating on the dynamo, while the dynamo is supplying the entire lamp load.

The regulator, auto-switch and other auxiliary apparatus are enclosed in closets either in the guard's section or in corridor stock in a corner of the corridor, and on non-corridor stock enclosed in a box similar in construction to a battery-containing box, which is slung under the coach in such a position that inspection is facilitated.

The battery, which is available in various sizes and capacities for the load required, is of robust electrical and mechanical construction ensuring long service. The positive plates are of an improved Planté type and combine a high specific capacity with efficiency and durability. The negative plates are undercut lead grids, into which the oxide is hydraulically pressed, and are formed into tough, non-shrinking and porous spongy lead plates. Teak lead-lined containing boxes or glass containing boxes can be fitted according to requirements.



Control Equipment Suspended Beneath a C. W. R. Coach

The Lamp Switch

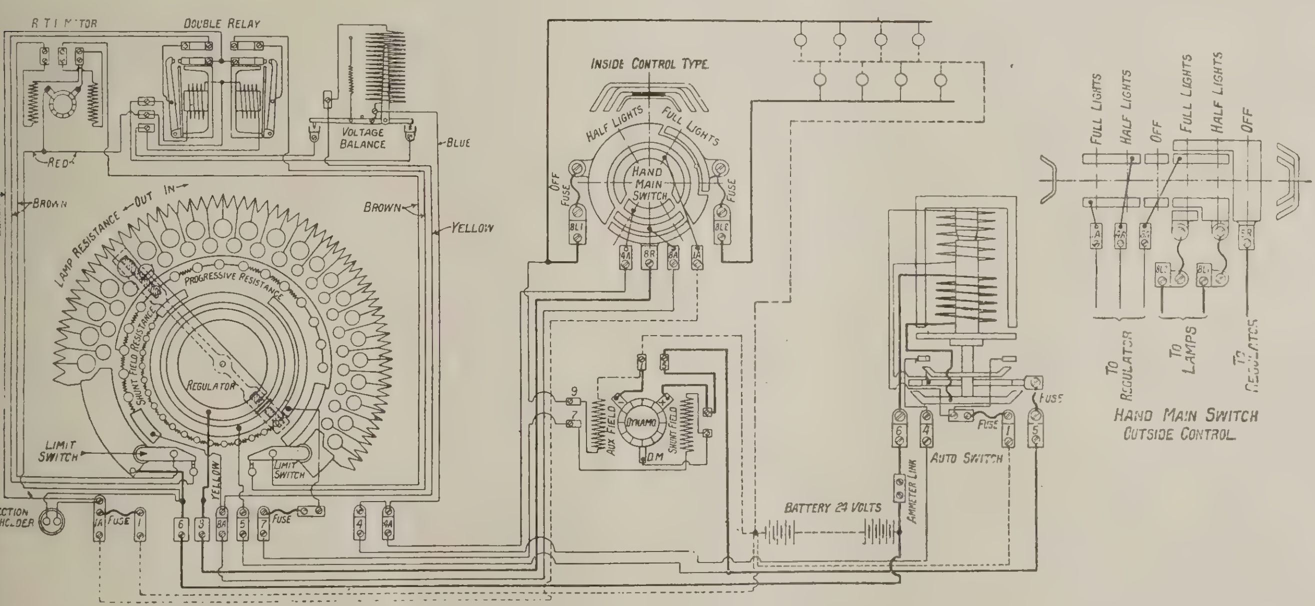
Control of the lamps is effected by either a hand-operated "interior" or "exterior" type main switch, according to the type of car lit, or if preferred, a "magnetic" or "distance" switch can be used. The magnetic switches are designed so that they can be operated independently by hand, or simultaneously throughout the train, electrically, by a "through control" switch, one of which is installed in each guard's section. The guard is thus enabled to switch the whole of the lights throughout the train either "on" or "off" as desired, without having to leave his compartment.

The Double Battery System

In cases where it is not considered necessary to maintain such close regulations of the voltage on the lamps as is obtained by using the Rotax-Leitner standard single-battery system, or where labor conditions, or other exigencies, do not warrant making any change in the technical principle of equipments already fitted, the Rotax-Leitner double-battery system can be employed with advantage. This system uses a double battery, lamp-resistance, and change-over switch, in place of the single battery and voltage regulator of the standard system. The advantages claimed for the Rotax-Leitner double-battery system are great reliability, low cost of maintenance and higher dynamo efficiency.

In the double-battery system the dynamo is identical with that supplied with the standard single-battery system, whilst the auto-switch is arranged to parallel the two batteries, in its "off" position, i.e., when the train is standing or running very slowly.

The function of the lamp-resistance is to regulate the voltage across the lamps when the batteries are being charged. The two batteries are paralleled through it, and the resistance only comes into use when the paralleling connections on the auto-switch and the lamp switch are open. The resistance then acts as a buffer between the battery which is being charged and the one which is supplying the lamp current.



General Wiring Diagram of Rotax Leitner Train Lighting System

The battery change-over switch alternates the position of each battery in the circuit every time the train starts, thus ensuring that a similar state of charge of each battery is maintained. The main lighting switch is a simple switch which can be constructed for either one or two lamp circuits, and is arranged to parallel the two batteries and so short-circuit the lamp resistance when no lights are

being used. An optional piece of apparatus is the overcharge preventer which serves to cut off or reduce the output of the generator when the batteries are fully charged.

Effective Use of the Double Battery

The dynamo and auto-switch function in a similar manner to that of the single-battery system. The effect of the use of a double battery and lamp resistance is as follows:—When the train is standing or running very slowly with lamps on, the two batteries in conjunction supply the current for the lamps, until a speed is reached at which the dynamo generates; the auto-switch then cuts in and opens the switch contact which parallels the batteries. Under these conditions only one battery is connected directly to the lamp, whilst the other is connected to the lamps through the lamp-resistance, and to the dynamo through the auto-switch. The latter battery then receives practically the whole of the dynamo charge. but as the voltage of this battery increases, there is a gradually increasing flow of current through the lamp-resistance until, when this particular battery is fully charged, practically the whole of the lamp current is derived from the dynamo, while the other battery, which has been supplying the lamps, receives any surplus charge which the dynamo may generate. This process goes on until the train stops. The auto-switch then re-makes the paralleling connection between the two batteries, and both batteries together supply the lamps. When the train starts again, the position of the two batteries in the circuit is changed over by the battery change-over switch, and a similar process to the above is repeated, so that both batteries are maintained in approximately similar condition. With lamps "off," the lamp switch connects the two batteries in parallel, so when the train is running the dynamo charge is divided between them, and they act as one battery of double capacity.

The system described above is based on sound electrical principles, all of which have been found perfectly trustworthy and satisfactory in service. The apparatus is manufactured at the firm's works at Willesden and Taunton, which are fully organized and equipped for the purpose.

Comparative Tests of Oil and Electric Lanterns

A series of comparative tests have been conducted recently by a committee of Chicago & Alton officers to determine the relative merits of a standard type of oil lantern and an improved type of electric lantern. The tests were made with two oil lanterns (one white and one red) and with a new combination white and red "Ecolite" electric lantern manufactured by the Economy Electric Lantern Company, Chicago. The tests were conducted at night under various weather conditions on the Chicago & Alton, and also by the standard footcandle meter method. The tests are reported as showing certain advantages in sighting distance and economy of operation in favor of the electric lantern.

The road tests were made between 8:30 and 10:30 p. m. on three different nights during February and March. On one occasion there was a heavy rain and fog, on another night it was slightly hazy but the moon was shining, while on the third night it was quite dark, but the weather was clear. Under these different conditions the two types of lanterns were compared at distances ranging from 600 to 8,100 ft. from the observers, and it is reported that in all cases the electric lantern could be seen more distinctly with both the white and red indications, than the oil lanterns. For example, on the dark night of March 23, when the weather was clear the white oil lantern could not be seen beyond 7,300 ft., while the white electric light was seen up to 7,700 ft. and was still visible at 8,100 ft. On this same occasion the red oil light was not visible at 6,700 ft., while the red electric light could be seen faintly at this distance and was not invisible until a distance of 6,800 ft. had been reached.

Using a foot-candle meter in a dark room, a comparison of illumination at various distances was made with the two types of lanterns set in the normal vertical position. The dark room test showed that the illumination from the white electric light exceeded that from the white oil light by 50 per cent at 6 in. distance and by 300 per cent at 30 in. distance. In the case of the two red lights, both were equal at a distance of 6 in., beyond which the red electric light showed higher foot-candle illumination.

The committee conducting the tests pointed out several factors to be considered when comparing these two light sources. The wick on an ordinary oil lantern must be continually regulated as to wick height in order to compensate for the charring or burning up of the cotton wick which is essential in order to maintain a candle-power value comparable to that secured when the lantern is first lighted. Air currents influence the candle-power of the oil lantern but do not have any effect on the operation of the electric lantern; also if the flame in an oil lamp is blown out during a severe wind or rain storm it is sometimes difficult to relight it in the open, which trouble is not experienced with the electric lantern.

A table of estimated annual maintenance costs for both types of hand lanterns was included in the report of the committee as follows:

Oil Lantern (Furnished by Road)

1 Lantern	$1.45
46 Pints oil	0.58
9 Wicks	0.18
12 White globes	3.24
3 Red globes	2.49
Totel	$7.94

Electric Lantern (Purchased by Employee)

Dry battery, 6 renewals	$2.16
Lamps (globes), 4 renewals	0.48
Total	$2.64

It was estimated that if the 1,200 conductors, trainmen and yardmen of the Chicago & Alton all used their own electric lantern and the company furnished the batteries and bulb renewals there would be a saving to the company of about $6,000 a year over the cost of maintaining oil lanterns.

After ten years of building, the $90,000,000 Union Station has been completed. It covers thirty-five acres of ground in one of the most important railroad centers in America. Its train shed covers an area of 460,000 square feet; its main waiting room, 26,500 square feet. Four roads will connect with it—The Pennsylvania, the Chicago, Burlington & Quincy, the Chicago, Milwaukee & St. Paul and the Chicago & Alton.

Electrification from the Executive's Standpoint

Discussion at Meeting of A. I. E. E. Stresses Need for Fundamental Steps in Standardization

AN unusually large attendance filled the auditorium at the annual meeting of the American Institute of Electrical Engineers, held on May 15, at the Engineering Societies Building, New York, when the subject of electrification of steam roads was discussed by a number of prominent executives of both railroad and manufacturing companies. Hon. Herbert Hoover, secretary of commerce, was not present but prepared a statement regarding the development of electrification. An abstract of Mr. Hoover's statement follows:

Statement from Secretary Hoover

I consider it of highest significance, that leaders representative of the railroads, electrical manufacturers, electric power industry, and our engineering societies, in a spirit of public service, are co-operating to lay sound basic plans for electrification of our railroads and terminals.

The people of the nation have a great and vital interest in this. Such plans, if wisely laid, will considerably shorten the time until benefits of increase in transportation facilities from electrification can be enjoyed. Standardization, at least in fundamentals, will facilitate the development of a co-ordinated electrified transportation system which will give maximum of service with best utilization of capital and labor. Failure to accomplish this preliminary standardization will result in enormous losses, which must reflect themselves in larger cost for transportation and in a reduced quality of service over what may be expected. Standardization of electric transportation equipment within the limits of agreement of a sufficient number of capable engineers will insure interchangeability of equipment between roads with consequent better utilization of locomotives and equipment. It will lower cost of manufacture of equipment, and reduce repair stocks. Simplification of standards will greatly enhance the efficiency of operation, since there will develop a uniformly trained group of railroad workers familiar with the standardized types of equipment. Uniformity in voltages, frequency, and other electrical characteristics will permit of much more effective application of electric power.

This standardization is important not only because of the benefits it will return but for the large losses it will prevent. We have here an opportunity to forestall waste. This is a much more tedious process of elimination of wastes once they have rooted themselves in an enormous industry. Failure to provide standards at this time will result in the adoption of a large variety of equipment which will later have to be brought into co-ordination with consequent waste of millions of dollars.

It is important that correlation of the electric light and power groups should be accomplished, to the end that electric energy may be brought to the railroads for electrification in sufficient quantity and with insurance of absolutely reliable service. Development of interconnected central station distributing systems, covering wide areas, makes possible a maximum utilization of our fuel and water resources and provides a pool of energy necessary for the electrification of transportation. Thus, the interlinkage between the railroads and the electric light and power industry, two of our great public utilities, will increase. The development of electrified transportation and the electric light and power industry should take place with the closest of co-ordination between them.

The successful accomplishment of the degree of standardization which can now be properly undertaken is a goal worthy of your best efforts. In the accomplishment of this, you will have rendered a public service of immeasurable value, saving enormous wastes, and giving great impetus toward electrification of our transportation.

Gerard Swope on Electrification of Railroads

The discussion was continued by Gerard Swope, president of the General Electric Company. He said in part: The position that the transportation system in the United States has reached, implying as it does the proud distinction of rendering the greatest service to the community as a whole of any in the world, is a monument and credit to the initiative and enterprise of private undertaking.

The part that the steam engine has played in this development is remarkable. Under the inspiration of the engineers associated with the railroads and the manufacturers, the steam engine has met the successive and seemingly insurmountable difficulties presented in moving greater tonnage at higher speeds. Our extensive transportation system has been so admirably served by the steam locomotive that we should not look for a change to another type of motive power unless there are some good and sufficient reasons for its adoption. The steam locomotive will undoubtedly continue for many years in the service with which it has been so closely identified for nearly a century. Further improvements may be expected which will increase the power and the fuel economy of steam locomotives, but however much may be accomplished in this direction there still remains the limitation of power imposed by restrictions in size of the locomotive boiler and firebox, and the inherently lower fuel economy in comparison with the modern steam electric power station.

The problem before the railroads and the country is more efficient, more economical, more expeditious methods of handling transportation and serving the people of the farms and cities in the most satisfactory manner. We believe that electrification will meet these requirements of a larger and increasingly larger portion of our railroads more fully than any other change in the transportation system, and a brief resume of the reasons therefore follows:

First, the saving of coal per year, if only one-half of the railroad mileage of the United States were electrified would be approximately 40,000,000 tons, or at the prevailing market price $120,000,000 per year.

Second, the electric locomotive is not restricted in its capacity, as in the case of the steam locomotive, the latter being limited in power by the size of the boiler it can carry. The central station from which the electric loco-

motive derives its power is stationary and may have a capacity many times in excess of any number of locomotives that may be on the line at the same time.

Third, the contribution to health, comfort and safety by elimination of smoke and dirt in tunnels and city terminals is apparent, as is also the increased value of property.

Fourth, capital expenditures for betterments on congested mountain grade divisions in many instances may be more profitably made for electrification than for the building of tunnels, construction of additional tracks and more steam engine facilities. The electric locomotive combines enormous tractive power with much higher speed which makes it most effective in increasing the carrying capacity of existing tracks.

Fifth, records kept over a long period of time clearly show that the cost of maintenance of steam engines greatly exceeds that of electric locomotives, hauling the same tonnage, over the same division and under the same operating conditions.

Sixth, for switching and branch line service the Diesel electric locomotive and the gas-electric car are available. These consist of a gasoline or Diesel engine driving an electric generator, which in turn drives electric motors. The unit is self-contained and independent of trolley or third rail.

This briefly sets forth the advantages of electrification for railroad service over steam. There is still difference of opinion in the minds of prominent engineers as to the relative merits of alternating and direct current, but this difference is far less important than the difference between either and steam locomotives.

This difference of opinion exists also in the minds of engineers outside of this country, but in most countries where this problem has arisen it has been met nationally and a national solution arrived at, even where in the same country, railroads were partly owned by the public and partly by the state. A few examples will be given. One system of electrification was adopted for all France, namely direct current, and they are proceeding with the work. In England also the direct current has been adopted nationally. In Germany and Switzerland alternating current has been adopted nationally. One would naturally expect that the different nations in Europe would differ in their solutions of the same problem be cause of their traditional differences and diversity of interest. Europe, notwithstanding the tremendous difficulties of the present economic situation is proceeding more rapidly to solve the problem of electrification of its railroads than we in the United States. Just as in this country we have a standard gage for tracks, standard couplers, standard brakes so as to make our equipment interchangeable, so it is to be hoped that a national electrical standard will be adopted with all its attendant advantages, allowing us to mobilize our resources for the greatest economic development of this country in peace and to protect ourselves most effectively in war.

Today the equipment in the terminals of New York City and Philadelphia are not so interchangeable, although both operate under similar conditions in congested areas of great wealth on our Atlantic seaboard.

As the Secretary of Commerce has so clearly pointed out, one common system would save hundreds of millions of dollars in equipment, that would otherwise be wasted, and the difficulties, cost and delays of interchange would be greatly decreased.

It is to be hoped and much desired that the railroad executives intrusted as they are with the custody of more than $25,000,000,000 of railroad property, owned by millions of people throughout the United States, and used by many more, will approach this problem from a national and American standpoint, in order to determine the best standard and interchangeable equipment to meet the varying conditions.

Personally I have the greatest confidence that this problem will be solved as the railroad problems in the past have been so ably and patriotically solved. To that end I am pleased and proud to pledge the assistance of the great organization with which I am associated, and irrespective of individual opinion and solely from the standpoint of national interest whatever system is adopted, to stand ready to give the best engineering and manufacturing service that can be rendered to the railroads of America.

Paul S. Clapp on Standardization in Equipment

The importance of standardization was still further stressed by Paul S. Clapp of the department of commerce, who spoke in part as folows:

Electrification of transportation requires the closest of co-operation and co-ordination between the railroads and the electric light and power industry. Both of these are public utilities, to whom the people of this country have intrusted the operation of the most vital functions in our national life—transportation and power. This is an expression of great public confidence. This trust carries with it the obligation to secure maximum utilization of natural resources, and to provide service of high quality with best use of capital and labor. It certainly carries an obligation to plan the best possible electrified transportation system and to prevent by some degree of standardization, the costly wastes which will otherwise ensue.

The exact details of what standardization are possible and desirable at this time, can only be determined after careful study by competent groups. There is no implication in this that designs will be crystallized at their present status and progress retarded. We refer to the determination of certain fundamentals which will be accepted as standard by the manufacturers and purchasers of electric railway equipment. These will embody the best thought and experience of our age and serve as guiding principles in the development of electrified transportation.

The adoption of such standards will insure future interchangeability of equipment between roads, thus increasing the utilization of locomotive and equipment. Any locomotive will be able to travel over the entire system. The concept of a patch-work of railroad mileages with a variety of electrical characteristics or contact systems limiting locomotive movements within prescribed limits spells inefficient operation.

Standardization will make possible more direct application of electrical power, with minimum losses from conversion. This means less complexity in equipment, decrease in initial cost, and better operating costs.

Standardized equipment will come to be understood by railroad workmen all over the country. We shall thus improve efficiency of labor in railway operation, and there will grow up uniformly trained railway groups familiar with this standardized equipment.

Failure to effect preliminary standardizations will not only deprive us of these benefits, and others, but it will

result in enormous and cumulative losses both in cost of equipment and operation.

The magnitude of these losses cannot be accurately predicted. We do know that they would be enormous. Australia must spend nearly a billion dollars to convert her 21 different railway gages to a common standard. Careful engineering surveys of basic industries show that wastes, largely due to excessive variation in product, amount to 30 per cent of cost.

This waste can be prevented only by standardization before any further large scale electrification takes place. Continued delay will result in these wastes becoming more deeply rooted in the whole system. Prevention of them by prompt but carefully considered standardization is an action which the public can rightfully expect.

E. M. Herr on Future of Railway Electrification

A summary of the past as well as a foresight into what may be expected in the years to come was given by E. M. Herr, president of the Westinghouse Electric & Manufacturing Company. An abstract of Mr. Herr's remarks follows:

It is generally recognized that adequate and efficient rail transportation is the prime necessity of modern civilization. Owing to the extent of our country and the fact that we have no internal water routes of moment, the importance of rail transportation here is accentuated so that the statement as to its necessity is more correct with us than in Europe.

During the period of the lag in railroad progress caused by the war, other methods of transportation were unduly stimulated, bringing self-propelled vehicles of many kinds into fields of transportation legitimately belonging to the railroads. I say "other kinds of transportation" were unduly stimulated because magnificent roads were furnished vehicular traffic at the public's expense. These roads are also maintained for the free use of self-propelled vehicles practically by public funds since only a nominal license fee is charged. This will not continue indefinitely and when an adequate charge for the unusual use of the public highways is put upon these vehicles, many will find it unprofitable to continue. All of this may be said to be outside the scope of an electrical manufacturer but my rather long railroad service in former years must be my excuse. And now, what of electricity in railroad service?

Electric locomotives require much less servicing, will work as efficiently in tunnels, subways, sheds or other enclosed places as in the open, and will permit of a much quicker and more efficient handling of cars in terminals than is possible with steam. Also, if the property on which the switching and terminal tracks are located is depressed, it can be used for buildings almost as well as if the terminal did not exist. In any event, the absence of steam, smoke, gases and noise, as well as other objectionable features incident to steam operation, permit of the location of such terminals near high class residence or business property.

Again, terminals and yards in large cities or congested places, can be worked so much more efficiently by electric operation that much space can be saved and valuable real estate reclaimed for other uses.

What can be said about main line and heavy long distance traffic? In this field while the amount of work actually done during the past ten years has not kept pace with the electric power development in the lighting and industrial fields, steady and continuous technical progress has been made and engineers and manufacturers are abundantly prepared to carry out the most ambitious electrification projects promptly and with assured results, no matter what the engineering requirements may be, for there have been numerous examples of many kinds of electrification, located not only in different parts of this country but all over the world.

A recent engineering achievement is the development of an electric locomotive which, in connection with a high tension alternate current contact wire, permits the choice on the locomotive of either single-phase or three-phase alternating current, or direct current motors of any voltage desired. Thus a very long step has been taken toward a standard or at least uniform system of contact wire which enables those railroads using this system to freely interchange traffic with locomotives of several different kinds.

The rapid development of the so-called "super-power system" of inter-connecting electric power plants is working to the advantage of the railroads as this plan makes available an abundant supply of reliable electric power at many different points and will enable a railroad to be electrified without the necessity for the very large investment for power house and machinery otherwise required.

During the past ten years little, if any, expansion of our railroad mileage has been made. The financial resources of the country were required for war purposes and after the war for a rehabilitation of our financial structure, and it is only recently that serious attention has been directed toward the necessity for developing our railroad systems.

Much progress has been made by the railroads during the past two years in improved efficiency and this has so well provided for current needs of business that the inevitable expansion and growth of our railroad facilities is to some extent masked by the better service rendered possible by the increase in efficiency. There is, however, a distinct limit to the possibilities of improvement along this line and we must look forward to a broader development of railroad facilities in the very near future.

Electric railways have been in successful operation for upwards of 20 years, during which time the cost of production of electricity has steadily decreased and the reliability with which it can be handled and its availability to railroads has constantly been improved.

With electric power, the trunk line railroads can concentrate much larger amounts of power in each train than is possible with steam locomotives on account of the limitation of the steam locomotive boilers. This concentration of power in main line traffic means larger trains, and higher speed, or both, if necessity requires, and almost without limitation.

The age of electricity is supplanting steam as a direct producer of power and railroads are no exception to this rule.

C. H. Markham on Railroad Electrification

Following Mr. Herr's paper a statement from C. H. Markham, president of the Illinois Central Railway Company, was read. An abstract of the paper follows:

The announcement that the manufacturers of railway electrical equipment are now in a position to develop and

construct any system of installation desired is of great interest to railway men.

Railroads have two objects in making expenditures for improvements in their properties. One is to give them the capacity to handle their constantly increasing traffic; the other is to enable them to perform that service at a constantly decreasing cost per unit of service and per unit of investment. I believe, as I am sure you do, that there are great possibilities for electrification in both these directions, but I want to remind you particularly of the possibilities that exist in the direction of reducing the cost of service. It is in that direction that the future of electrification largely lies.

Most of you are no doubt familiar with the fact that within the last two years the railroads have spent more than one billion dollars a year for property improvements. Their future needs have been estimated as high as one billion dollars a year for some time to come. If this rate of expenditure is maintained, even in the approximate, it means that in a comparatively few years the railroads will have doubled the amount of their property investment. If they are to realize a reasonable return upon this doubled investment without increasing their rates, the property improvements for which the money is spent will not only need to increase their capacity, but will also need to effect reductions in the cost of operation substantial enough to overcome their increasing taxes and produce a margin of profit.

In the joint study about to be undertaken I want to remind you that each railway project constitutes a problem of itself. The conditions that make problems in railway operation vary from one railway system to another. Your study will need to be sufficiently diversified to meet the varied conditions of location, traffic, and so on.

There is another factor that will have a great bearing upon the future of electrification as applied to the railway industry, and that is the factor of simplicity.

Standardization is still another factor that will do much to make installations of electrical facilities successful, bearing in mind that they will have to be operated and materials on hand and to facilitate the making of both sonnel of a railroad must necessarily have a large degree of flexibility. The man who is trained to operate or repair a facility in use at one point must possess the same qualifications with respect to other comparable facilities. Interchangeable parts are necessary to reduce stocks of materials on hand and to facilitate the making of both light and heavy repairs. All these things call for the greatest standardization of design that is compatible with efficiency and economy.

The final address of the evening was presented by Robert J. Cary, general counsel, New York Central Lines. He spoke extemporaneously on certain phases of electrification developments.

New York City will have the world's largest electric generating station when the East River Station of The New York Edison Company, now under construction, is completed. This one station, which will cost in the neighborhood of $50,000,000, will have a capacity of 700,000 kilowatts, or approximately 1,000,000 horsepower—enough to light at least 3,000,000 six-room homes. With the addition of this new plant there will be on Manhattan alone electrical generating equipment sufficient to light the homes, factories, streets and public buildings of all New York state, exclusive of New York City. The new station, itself, operated at full capacity, would be capable of serving any state in the United States outside of New York, according to data compiled by the United States Geological Survey. It is expected that the building itself, which will cost approximately $12,000,000, will be completed by the end of the year, and that the initial installation of generating equipment will be completed in the spring of 1926. The station will contain nine gigantic turbo-generators, each having a capacity of 60,000 kilowatts—80,000 horsepower—or 10,000 kilowatts greater than the capacity of the largest single unit machine now in operation, and additional equipment which will give a total capacity of 700,000 kilowatts.

Laja Falls—The Niagara of Chili

Gas-Electric Motor Coach Built for the New York, New Haven & Hartford by the J. G. Brill Company

Gas-Electric Car for the New Haven

Arrangement of Control Permits Gas Engine to Operate Under Most Favorable Conditions

A GAS-ELECTRIC motor coach, with a seating capacity for 60 passengers and a baggage compartment 11 ft. 3 in. long, has recently been built for the New York, New Haven & Hartford by the J. G. Brill Company, Philadelphia, Pa. The car in its essentials has been built to the specifications of the railroad and is designed for double-end operation without a trailer. The car weighs 73,420 lb. of which 40,100 lb. is on the front truck and 33,320 lb. is on the rear truck.

The car is 60 ft. in length over end sills and is laid out in four principal compartments in addition to the vestibule at the rear end. The power plant and the forward control equipment occupy a compartment at the front end of the car, which extends back 10 ft. from the outside of the front end sill. Behind the power plant is the baggage compartment which is 11 ft. 3 in. long. In one corner of this compartment is located the Peter Smith hot air heater. There are folding seats in this compartment for nine passengers. The smoking compartment, which is immediately in the rear of the baggage compartment, is 10 ft. 2½ in. long and has a seating capacity for 20 passengers. The main passenger compartment, which occupies the remainder of the car, seats 45 passengers. The seats in both passenger compartments, which were furnished by the builder, are arranged to seat two passengers each on the right side of the car and three passengers each on the left side of the car and aisle arms have been omitted. The shorter seats are 33 in. in length over-all, while the longer seats are 51 in. in length over-all, with a clear aisle 20 in. wide. All seats, except those against the partitions, are reversible.

At the rear end of the car is a vestibule 2 ft. 11 in. in width, with steps and O. M. Edwards trap doors on both sides. The vestibule side door openings have a clear opening of 2 ft. 6 in. wide. Back of the vestibule, occupying space at the middle and one side of the car is the rear end control compartment. Adjoining this compartment on the right side is the saloon.

Every effort has been made to keep down the weight of the car, without sacrifice of the strength essential for a car of this character intended for individual operation. The underframe is built up around two 12-in., 20.5-lb. center sills, which are unbroken from end sill to end sill. These sills are reinforced with channels of the same section, approximately 6 ft. long extending 3 ft. in each direction from the center of the front bolster. The side sills and end sills are of 3½-in. by 2½-in. by ¼-in angles, each in one piece, the sills all being tied together with 3-in., 4.1-lb. steel channel cross ties which extend the full width of the body. Additional fastening is provided at the side sills by 3/16-in. pressed steel webs, the bolsters being of the box type with 3/16-in. by 10-in. steel cover plates top and bottom, while the transoms are of the single web type, with 6-in. top and bottom cover plates.

The principal members of the body frame are 1½-in. by 1½-in. by 3/16-in. T-bars framed into ash posts. The T-bars are securely riveted to the side and end sill angles at the bottom and to the end plates and side letter boards at the top. A belt rail of ⅜-in. by 3-in. steel extends in a continuous piece on each side of the car from the rear baggage door post to the front vestibule door post and in a third continuous piece around the rear end of the car between the rear vestibule door posts. Each end plate is made in one piece of ⅛-in. steel, 6-in. wide to which is riveted an angle to form a 1½-in. flange. The front plate extends around on the sides of the car about 4-ft. back of the rear baggage door posts. Similarly, the rear end plate extends around on the sides of the car to the first window post in front of the forward vestibule door posts. The carlines are 1½-in. by 1½-in. by 3/16-in steel T-bars, each in one piece, secured to the side posts with splice plates. Nailing strips to which the roof sheathing is attached are bolted to either side of the carline webs.

The outside sheathing and the letter board are of 3/32-in. copper bearing steel sheets. The board roof is finished with a heavy coat of white lead paint, in which is embedded a covering of No. 8 canvas, stretched and tacked.

The top flooring is laid on a special flooring of No. 22 gage corrugated copper bearing steel sheets, the corruga-

tions of which run lengthwise. These sheets are laid on top of the channel cross ties of the underframe and extend the entire length of the car body. Yellow pine nailing strips for the top flooring are laid crosswise above the sub-flooring and are bolted through the latter to the channel cross ties. The top flooring in the passenger compartment is of 1 3/16-in. yellow pine laid lengthwise and nailed to the cross strips. In the baggage compartment 1⅛-in. flooring is used. This also runs lengthwise of the car and, like that in the passenger compartment, is tongued and grooved. The aisle is fitted with maple mat strips secured to the floor with countersunk wood screws.

The interior of the car is finished with 3/16-in. Agasote below the windows, and No. 22 gage steel above the windows. The ceiling is not lined, the finish being applied directly to the roof and carlines. Continuous basket racks are applied on each side of the passenger compartments and each window post is fitted with a double coat hook. It will be seen that an advertising card holder has been placed on each side of the car below the basket rack.

Lamp sockets for 32-volt lamps are placed along the inside longitudinal members of the roof structure, the locations being clearly shown in the interior photograph. The windows are fitted with Brill metal sash and Renitent metal posts which hold the windows securely against rattling and permit their ready removal from the casings. Ventilation is provided by Garland exhaust ventilators mounted on the roof and fitted with shutters in the ceiling. There are five of these in the passenger compartment, two in the engine room, two in the smoking room and two in the baggage room, with one Globe ventilator in the saloon.

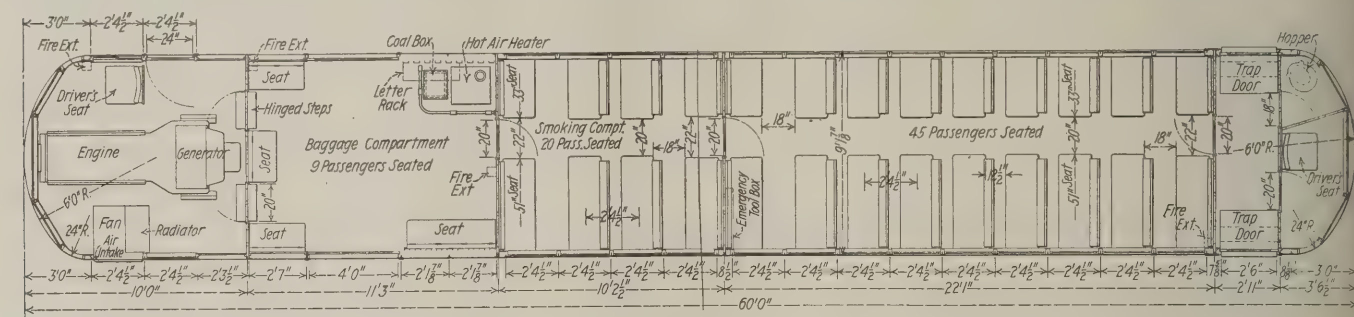
Power Plant

The power plant consists of a Sterling-Dolphin, six-cylinder engine designed to develop 180 hp. at 1,200 r.p.m. direct connected to a General Electric separately excited, 110-kw. direct current generator, with commutating poles and differential series field. Compactness is secured by mounting the engine and generator on a common sub-base so that an outboard bearing on the engine end of the generator need not be used. The generator shaft is connected through a flexible coupling which relieves the crank shaft of the shocks caused by the piston impulses when the shaft is rigidly connected to a heavy mass such as a generator armature. The cylinders of the engine have 5¾-in. bore and 6¾-in. stroke and are fitted with two sets of inlet and exhaust valves per cylinder, thus keeping down the weight in proportion to the area of valve opening and increasing the effectiveness of cooling through the water jackets with which the valve seats are surrounded.

The water circulation is provided by a gear driven pump. The cool water from the radiator is first circulated through the lubricating oil cooling tank; thence it passes through the exhaust manifold jacket to the cylinder jacket and thence to the inlet manifold where the water at its highest temperature warms the incoming gas. The lubricating system is of the pressure feed type and includes a filter and strainer through which the oil is constantly circulated.

The engine is fitted with three sets of spark plugs and three distributors, the three spark plugs in each cylinder firing simultaneously. Owing to the provision of double end control which will permit the regular operation of the car in either direction, less dependence can be placed on the natural air draft through the radiator than would be the case were the car to be run continuously in one direction. In the New Haven car the radiator has been placed in the left side of the car adjoining the engine, with a duct leading forward through the engine room to the louvers in the front of the car below the belt rail. A fan driven by a 3-hp. motor operating at 1,300 r.p.m. is placed just inside the radiator and serves to draw the air in through the openings in the front of the car and drive it out through the radiator at the side. Louvers in the opening through the side of the car deflect the air downward as it leaves the radiator.

The car is driven by two 105-hp. General Electric railway motors, one mounted in each truck. The control is effected largely through the engine throttle. A drum type controller is used to reverse the motors and to provide

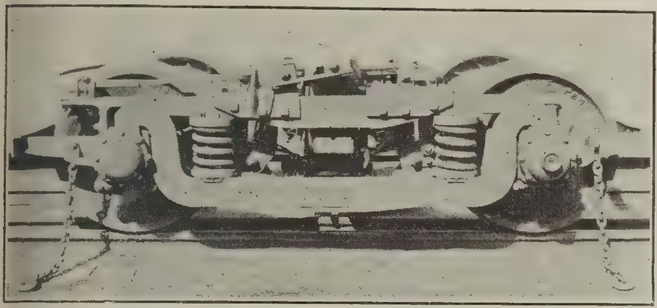


Floor Plan of the Gas-Electric Motor Coach Built for the New York, New Haven & Hartford

Interior View of the Passenger Compartment Looking Towards the Front

three torque ratios between the power plant and the rail. Two of these are effected through series and parallel connections of the motor and the third by shunting the motor fields. As the latter is intended largely for high speed operation under conditions requiring a comparatively small amount of power, it is provided on each of the two controllers in the forward direction, only, while series and parallel connections are available in both directions on each controller.

The engine throttle quadrant is fitted with a cut-out switch which controls the battery circuit to the exciter



The Trucks Are Equipped with Timken Roller Bearing Journals

field. This switch is opened automatically by completely closing the throttle. In this position the engine continues to idle with the generator completely unloaded. With this arrangement it is unnecessary to touch the controller handle when making ordinary station stops, the entire control being effected through the throttle. When power is required to operate the air compressor and the blower fan while the car is standing, the controller is thrown into neutral position and the throttle opened as far as may be required. This automatically closes the exciter circuit cut-out so that the generator takes up its load.

Each of the two control stations is equipped with a controller, a throttle lever, the Westinghouse traction brake valve and Duplex gage, the siren and bell ringer valves, headlight switch and starting motor button. The entire control of the car is thus placed in the hands of the operator at either end, a feature which affords little difficulty in the case of the electric type of transmission. In addition to the above equipment, in the engine room there is an instrument board which contains the oil pressure gage, a water temperature register, a tachometer showing the revolutions per minute of the crank shaft, and the ignition switch.

The Trucks

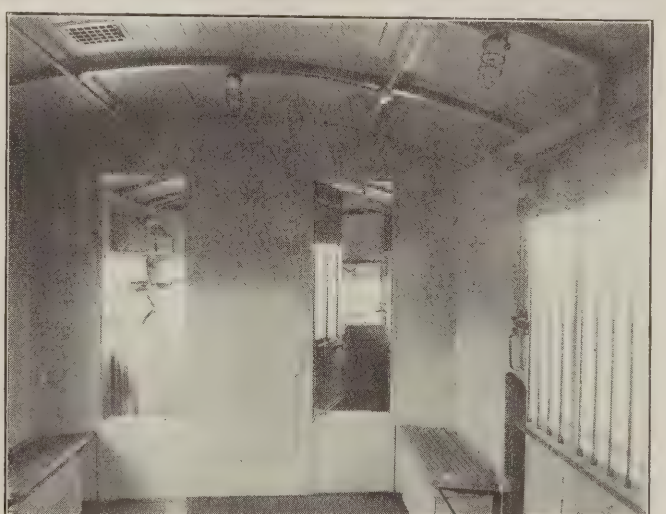
The trucks are of the Brill 27-M. C. B. type, equipped with Timken roller bearing journals and 33-in. Davis cast steel wheels. This truck, which is a well established design for use on electric suburban cars, has a number of interesting features from a steam railroad point of view. Probably the most interesting of these features is the truck bolster guide. This consists of links arranged to provide vertical and latteral flexibility of movement for the bolster, which connect the ends of the track bolster to the truck transom. The reaction between the transom and the bolster caused by the traction of the power-driven axle or by the application of the brakes is transmitted to the bolster through these links without the usual reaction through chaffing plates which in a measure destroys the freedom of action of the springs.

Another interesting feature is the location of short coil springs between the top of the elliptic springs and the bottom of the bolster. These springs provide additional flexibility which comes into play under light loads when the stiffer springs below are less effective in absorbing track vibrations than when under heavier loads.

The spring plank is suspended between links which are held together at the bottom by a bolt, on the end of which is placed a spiral spring. This spring is drawn up in compression by the nut on the end of the bolt, thus producing a friction brake between the surfaces of the spring plank and the ends of the links, which considerably reduces the latteral freedom of motion of the spring plank.

General Characteristics

There are two features of electric transmission which are of particular value in connection with the use of the gas engine as a source of motive power. The most important is the complete flexibility of engine speed with respect to the torque of the driving axles. This permits the operation of the engine at approximately its best operating speed, the electric transmission taking care of the variation in speed and torque at the rail. Another feature is the possibility of having self-regulation to prevent exceeding the predetermined maximum engine speed by the proper design of the generator in relation to the engine characteristics. This is possible in principle because of the fact that the power output of the generator continues to increase in proportion to the armature speed considerably beyond the speed where the power output of the engine ceases to increase in proportion to its speed.



Interior View of the Baggage Room Looking Through the Engine Room Doors—The Location of the Operator's Seat Permits Observation Both to the Front and Rear

The New Haven car is designed to operate at a maximum speed of 57 miles an hour, and is expected to maintain average speeds on level track varying from 25 miles an hour with stops averaging one per mile, to 37 miles an hour where the stops average one in eight or more miles. This is based on a conservative maximum acceleration allowance of 1.5 miles an hour per second. For a one per cent grade the average speed for the longer intervals between stops is reduced to approximately 27 miles an hour.

The J. G. Brill Company now has under construction a gas-electric car, which will be equipped with a generator of 160-kw. capacity driven by a motor developing 250 hp. at 1,100 r.p.m.

Turbo-Generators for Use with Train Control*

Machines Which Have Proved Satisfactory for Locomotive Lighting May Serve Equally Well in New Development

IN the solution of the train control problem so far as the locomotive is concerned it is natural that attention is directed to the turbo-generator now furnishing power for locomotive lighting. This unit is rightfully regarded as the proper source of current supply for train control. Locomotive lighting has come to be a most important and necessary phase of railroading. Train control will probably reach the same status. It is logical therefore to consider here the steam-electric unit which has so successfully met the problems of locomotive lighting.

Locomotive turbo-generators present a problem entirely different from that of the powerhouse turbo-generator. It is called upon to operate under all kinds of weather conditions ranging from excessive heat to extreme cold. It must successfully withstand the severe shocks imparted to it from the locomotive. It must have constant speed and voltage control over a wide range of steam pressures which normally are 125 to 225 pounds gage pressure. It must be accessible and permit of easy maintenance. Except where train lighting from the locomotive is practiced, it is a unit of small output ranging from 500 to 1500 watts and therefore correspondingly difficult in design when efficiency is considered.

Practically all of the turbines used in headlighting and now in train control can be considered as of the impulse type since the use of a nozzle is employed in which the steam is expanded to the pressure present in the turbine chamber surrounding the rotor. This, as a rule, is very little above atmospheric pressure varying from zero to several ounces, depending on the equipment used.

The aim of the designer is to proportion the throat and mouth of the nozzle to its length, so as to obtain the greatest velocity in the steam jet and thus impart to the turbine rotor, through the medium of the buckets, the greatest possible amount of energy. Next to the nozzle in importance is the turbine wheel, or to be more exact, the buckets, against which the steam jet impinges. These are very carefully designed in order to eliminate any force counter to the direction of rotation. Steam enters the buckets smoothly and after exerting the maximum force thereon, is allowed to escape from the rotor without eddying in successive buckets. In many instances the steam, as it leaves the first row of buckets, is redirected by means of a guide passage either through the same row of buckets or through a second set. An average of the increased efficiency by so doing approximates 15 per cent.

The angle of the nozzle with respect to the buckets, is such as to allow this smooth course of the steam jet into the buckets whose spacing permits of correctly designed back angles in order to get the greatest useful energy imparted to the turbine rotor without interference. While considering the nozzle and buckets it might be well to mention the importance of using materials which have high resistance to steam cutting. Bronze or brass having very little tin content, should be employed. Tin in an alloy lowers the melting point and results in a softer metal which does not have the ability to withstand the cutting of the steam due to the many solids which are carried with it. Efficiency throughout the life of the turbine should not differ materially from that when new, if proper precaution is taken in the selection of materials embodied in the construction of the nozzle, buckets and valve.

In all headlighting sets with two exceptions, speed control is obtained through the medium of a fly ball governor comprising two weights acting on fulcrum edges counter to a spring which in some equipment is in tension and in others in compression. The relative merits of tension over compression springs will not be considered here. The weights act against the spring force on a thrust face, collar or pin as the case may be according to the type of equipment used, which acts counter to a thrust member such as a carbon ring through the co-called governor arm in opening or closing the valve, thus controlling the supply of steam delivered to the turbine wheel—hence regulating the speed.

Speed control must be inherent in the turbine or, no matter how well designed the generator, good voltage regulation can never be attained. Today speed control on headlighting and train control sets can be kept within 2 per cent of their rated speed in revolutions per minute from no load to full load. This will be increased slightly, however, when taken over wide ranges of pressure such as 125 lb. to 225 lb. gage.

In order to obtain efficiency in water consumption per kw. hr., it is necessary to work the turbine at a fairly high rate of speed which in head-lighting and train control sets range from 2,000 r.p.m. to 4,000 r.p.m. By so doing the peripheral speed of the turbine wheel is made to approach more nearly the velocity of the steam from the jet which is one of the requisites for efficiency and therefore lower water consumption per hour.

Having the turbine with characteristics as nearly 100 per cent as is mechanically possible to attain, attention can then be directed to the generator end of the equipment. The severe service and unusual operating conditions together with the fact that these machines must be maintained under all kinds of local conditions, make it imperative that the generator be as simple, and, at the same time, as rugged as possible.

Before train control development, the turbo-generator had, of course, only one duty to perform, that of lighting the locomotive most efficiently. While passing it might be well to set forth the loading in lamps ordinarily found on the locomotive. It will be appreciated that this will vary somewhat with different railroads and with the different classes of engines. As an average, however, the lamp loading is found to be about 375 to 425 watts. About 100 watts of this total is divided up among the several gage lamps, engineer's order lamp and the fireman's deck light. The headlight is 250 watts and can be operated through a dimmer resistance of approximately 3 ohms by a single pole double throw switch in the cab. Where pilot lamps in the headlight case or classification and marker lamps are employed the loading is in-

*Abstract from a paper presented before a meeting of Signal Engineers in Chicago by J. J. Kennedy, electrical engineer for the Pyle-National Co.

creased some 60 watts. The use of "back-up" or tender lamp adds 25 watts to the loading. Summing these up over average conditions the aforesaid figures of 375 to 425 watts as the usual loading in lamps is obtained.

The cab load is with few or no exceptions connected directly across the generator terminals without the use of a switch. Thus whenever the generator runs there is light in the cab and as a result under normal operation the turbo-generator seldom runs under what would be called "no load" operation.

It is to be understood, of course, that all headlighting turbo-generators are 32 volts, which is the universal standard for headlighting today, the only exception being Europe, where 24 volts is employed. With only two exceptions, neglecting very special machines, all turbo-generators are direct-current. The two exceptions are machines of the inductor alternator type, high frequency, using permanent magnets as magnetic field.

Adaptability to Train Control

Many train control engineers particularly those interested in intermittent inductive devices prefer to operate at a voltage considerably lower than the normal 32 volts available in the turbo-generator. This is in order to use a small standby battery or to minimize inductive effects in their relays and other apparatus. Thus we are confronted with the problem of obtaining this low voltage (approximately 14 volts) from the turbo-generator. In any one of three ways this may be accomplished and the problem resolves itself to judging which of the three has the most advantages, not only from an economical standpoint, but also from the ultimate assistance that such a method would give to the train control apparatus under every day operating conditions. The first of these is by inserting resistances in series with the train control. Another is to incorporate in the turbo-generator two separate armatures, one for 32 volts and another for the lower train control voltage. The third and the one which seems to have the most advantages is the use of a motor-generator set, the motor, of course, being wound for the 32-volts and the generator side dependent upon the train control voltage desired. By this latter method the lower voltage is not only obtained, but we have also the decided advantage of isolating the headlighting circuits from the train control circuits, thus minimizing the danger due to grounded wiring, which is the ever-present problem in locomotive lighting no matter what precautions are taken. The use of the turbo-generator incorporating two windings may in the future when train control apparatus has become standard, be advisable, but at this time when changes are frequent and necessary it would seem inadvisable to use turbo-generator equipment other than standard. Some consideration has been given to a separate turbo-generator of small output for the train control load only, but the fact that the output is small does not lessen in the least the maintenance cost. If such a machine were used it would mean two turbo-generators per locomotive, one for headlighting and one for train control, neither one of which could be used as a standby in case of failure of the other. Therefore, economically and from a safety standpoint such an arrangement must be condemned.

It is commonly supposed that the headlighting turbo-generator is run only at night when the headlight is required. Such is not the case, for with the increased size of locomotives and the multiplicity of gages, etc., in the cab the engineman finds it necessary today to have the generator running to furnish lights in the cab, even in the day time. An average of the time that the headlight turbo-generator is in operation will exceed 75 per cent of the time the locomotive is in operation, and in many cases will be 100 per cent. The utilization of the turbo-generator the extra time is not going to add appreciably to the cost of operation or maintenance. This has already been accepted as standard practice by many of the roads which are operating continuous inductive types of train control.

The use of the two turbo-generators each capable of carrying both train control and locomotive lighting loads is coming to be common practice. These are so interconnected through switches as to permit of carrying either train control or headlighting on separate machines or all on one as desired, thus forming what we might rightfully call 100 per cent "standby service."

Additional Design Problems to Be Solved

In addition to close voltage control there is being imposed by the continuous induction types of train control a second requirement which heretofore has placed no part in the locomotive turbo-generator. This is that the voltage wave shall be entirely free from any pulsations or alternations since any such irregularities will result in loading up the vacuum tubes used to amplify the currents picked up by induction from the "track" and "loop" circuit. The major part of these irregularities experienced from the turbo-generator in conjunction with the continuous induction devices, has not been due to inherent defects in the turbo-generator equipment, but rather from disorders which creep in as a result of operating conditions such as excessive vibration, poor brush fits or surfacing, worn bearings, etc. Designs of equipment are under way, however, and will be soon available, which will not only be free of all such irregularities, but will be of such a nature as to insure against any change due to operating conditions and common maintenance practices.

In conclusion, it is well to sum up what should constitute the basis of comparison of turbo-generators when you are called upon to analyze the relative merits of the various equipments. Train control as well as lamps is designed to operate most efficiently and with longest life when operated at that particular voltage for which it was designed. Therefore the first and greatest requisite is voltage control. This control as pointed out previously depends on speed regulations, or, in other words, "governor control." Since the generator is called upon to operate under temperatures ranging from excessive heat to extreme cold, tests as to heating effects on the terminal voltage are very much in order.

Efficiency will naturally follow as the next consideration, and to the operating officer this is by no means secondary. Coal saving is more than a mere slogan! And let us consider that a saving of even 20 lb. of water per hour per engine mounts to huge proportions in the course of a year. Assuming coal at $6.00 per ton on the tender (which is an average figure when the entire States are considered) and with the nominal figure of 7 pounds of water per pound of coal we would effect, assuming 6 hrs. per day and 300 days operation per year, a saving of

$$\frac{6 \times 300 \times 20 \times 6}{2000 \times 7} = \$15.40$$ per locomotive. This is only to show what can be saved with proper attention paid to the

water rate of the particular equipment used. When running water tests it is not necessary to take water consumption readings at more than two loadings, this for the reason that in all headlighting equipments the chart showing water consumed per hour against load is a straight line. Common practice is to make "no load" and "full load" tests and then connect the two points thus found on the chart with a straight line. Then any intermediate value can be directly obtained.

Accessibility is a feature which perhaps may seem stressed too much, but it should be remembered that these turbo-generators are on a hot locomotive, and the time is usually short for maintenance and often when trouble develops the engine has already been "called." The equipment must then be repaired on the engine. It can never be made a bench job except, of course at the "slipping" or general overhauling period. So ease of maintenance is not something to be desired, but rather a necessity.

Bearings and bearings mountings with the methods of lubrication, capacity of oil cellars and effective sealing against water or dirt therein, are just a few more of the things which the operating man choosing equipment must decide.

The turbo-generator has proved its merits in locomotive lighting. It *can* be depended upon with safety to operate the train control equipment.

Storage Battery Locomotives for Northern Pacific

The Northern Pacific has recently placed in service two of the largest storage battery locomotives that have ever been built. The locomotives are for heavy duty on the Yellowstone division and will be operated by Foley Brothers, who have the contract for coal production in the Rosebud fields recently opened at Coalstrip, Montana. The storage batteries are the largest ever made by the General Electric Company, builders of the locomotives; they are the same type as those perfected for submarines service during the war.

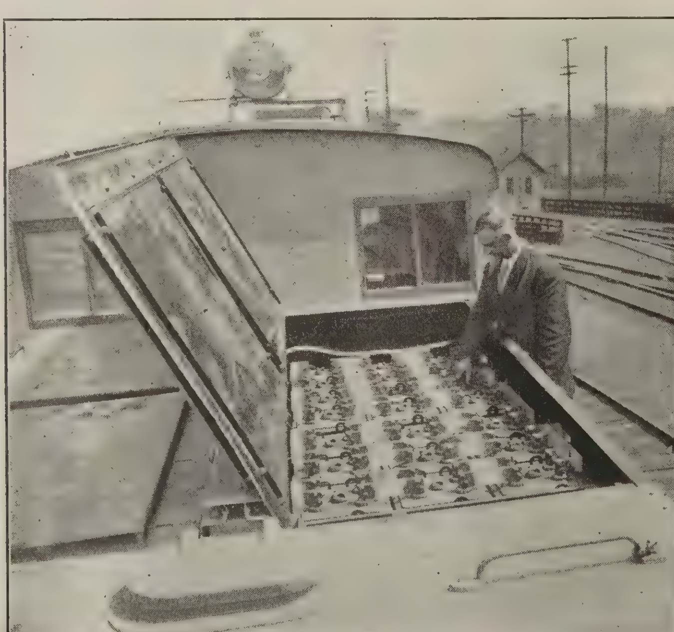
Before the decision was made to use the storage battery locomotives, careful investigation was made of capital and operating costs of steam locomotives, Diesel-electric locomotives, gas-electric locomotives, electric locomotives operated by trolley and third rail and storage battery locomotives. Electric power was already available from the Montana Power Company, but the operating conditions presented difficulties for the employment of either trolley or third rail electric locomotives. Having electric power available at low cost, made it uneconomical to attempt to generate power by oil or gasoline and for these reasons the storage battery locomotive was chosen.

Unusual operation conditions make it necessary to charge the battery while the locomotives are in service and in order to accomplish this a plan was worked out, which is claimed to be the first of the kind ever developed. A motor-generator set, located on the locomotive is operated by means of a flexible cable during the period that the locomotives are spotting cars at the coal loading shovel. This operation requires about 1½ hr. which is long enough to change the battery with as much energy as is used in making a round trip of three miles to the storage yard, with 10 loaded cars of 50 tons each and returning with the corresponding number of empty cars.

Descriptive Data

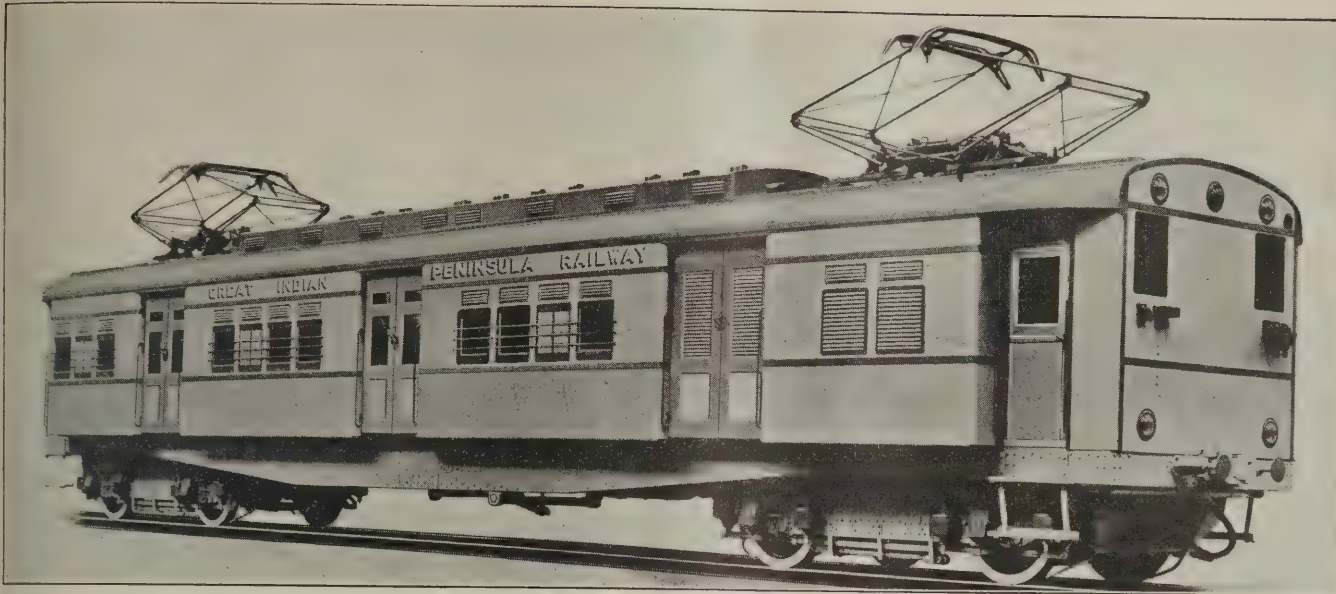
Weight cf locomotive	70 tons
Length inside coupler knuckles	42 feet
Number of motors	4
Type cf motcrs	250 volt, single geared, enclosed commutating pole, railway motors.
Weight per driving axle	35,000 lb.
Storage battery, Exide Ironclad	90 cells, F. L.—21
Weight of battery	17 tons
Tractive effort	42,000 lb. at 30 per cent adhesion

One end of the charging cable is connected to a set of transformers placed on a coal loading shovel where the voltage has stepped down from 2,200 to 400. The remainder of the cable is wound on a reel mounted on a small trailer car. This reel automatically winds and unwinds as the locomotive is moved forward or backward.



One of the Battery Units of the New Northern Pacific Storage Battery Locomotives

Exterior View of One of the Locomotives; H. E. Stevens, Chief Engineer of the Road in the Foreground



Multiple Unit Car for The Great Indian Peninsula Railway in India

Electric Traction Inaugurated in India

Motor Cars are Effectively Fire-Proofed and Are Designed to Run Through Water Two Feet Deep

ELECTRIC railway service was inaugurated on February 3, 1925, on the Bombay Harbor branch of the Great Indian Peninsula Railway in India. The present electrified section extends north and east from the Victoria terminal a distance of 12 miles; this includes 28 miles of single track. The total route-mileage on completion of the suburban electrification will be 45 and the total mileage of single track 128. Four tracks will be equipped as far as Kurla and two tracks from Kurla to Kalyan.

Power is purchased from the Tata group of hydro-electric supply companies. It is supplied to the substations as 22,000-volt, 50-cycle, three-phase power and there converted and delivered to the single catenary overhead contact system as 1,500-volt direct current power.

The catenary is made up of 37 gage, .115-in. copper and the contact wire is of the grooved type .125 sq. in. in sections, making a total section of copper of .625 sq. in. per track. The relatively heavy contact wire used is of assistance in preventing the formation of "hard spots" due to action of the pantographs. The track rails are bonded with two bonds per rail joint. These are provided with solid heads which are expanded into holes in the web of the rail, and in order to make theft difficult they are installed under the fishplates which are of special design to give the required clearance.

Rolling Stock

The trains are made up in units of four cars, each unit consisting of one motor car and three trailers; normally trains will consist of eight cars. The contract for cars, which was awarded to Cammell Laird & Company, included 13 motor cars, 26 driving trailer cars and 13 trailer cars 12 ft. wide and 25 motor cars 10 ft. wide. The length of the 12-ft. coaches is 68 ft. and the height from rail to top of roof 13 ft. 8 in. The trailers weigh 82,800 lb. and the motor cars weigh 142,800 lb. The larger coaches are capable of carrying 200 passengers.

Owing to their unusual width and the existing platforms, a special design has had to be embodied in the coaches, there being a considerable amount of body overhang on each side of the underframes, which are of the solebar carrying type. The coaches are fitted with central automatic couplers of the M. C. B. type, and side plungers are provided to ensure easy riding. On each side of the trailer coaches are three doorways, each 4 ft. 4 in. wide and provided with a pair of sliding doors, while doorways 2 ft. 4 in. wide and with a hinged door opening inwards are provided at each end. The floor is of Decolite composition laid on dovetail sheeting, and asbestos has been used in the construction of the roof and sides of the vehicles.

The whole of the electrical equipment on the coaches, with the exception of the lighting and ventilating, was supplied by The English Electric Co., Limited, the consulting engineers on the electrical portion of the contract being Merz and McLellan.

There are four motors on each motor coach, connected together in pairs in permanent series, the two pairs being controlled by the ordinary series parallel method. They are a self-ventilated railway type and develop a rated horsepower of 275 each at 700 volts. The power circuits are so arranged that the field and interpole coils of all the motors are always on the earth side of all the armatures.

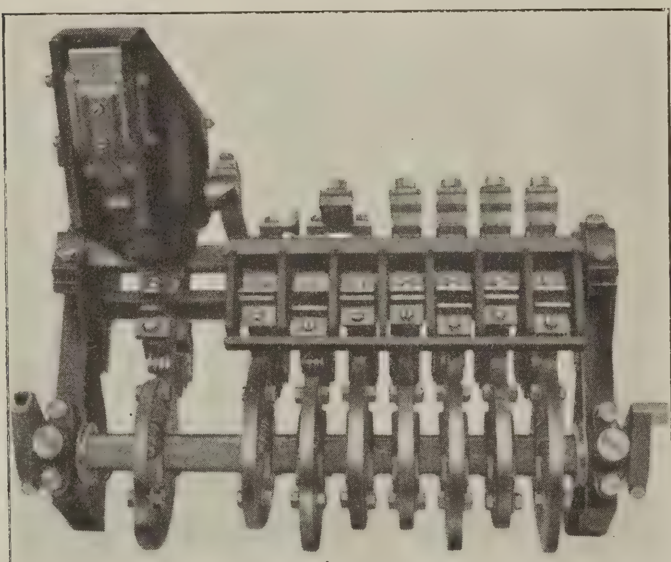
Precautions Against Water

It is noteworthy that the new trains will be required during the monsoon period to run over flooded portions of the line, when the depth of water will be as much as 2 ft. above rail level. In such circumstances the motors

are liable to be almost completely submerged, and special steps have, therefore, been taken to meet this condition. All the oil fillers and the commutator covers have been provided with water-tight joints, and special air valves have been provided for the inlet and exhaust openings for the ventilating air. These valves can easily be closed by means of a special spanner, so that during flood times the motors will run as totally enclosed motors.

Control Gear

The control gear is of the "English Electric all-electric camshaft" type, arranged for automatic acceleration, and embodying the following essential features:—(*a*) A camshaft rotated by a small motor under the control of relays and of the master controller, the camshaft carrying a number of cams which open and close the contactors in definite sequence; (*b*) two line breakers to break the main circuit, and (*c*) the usual electrically-operated auxiliary gear, comprising reverser, etc. The use of cams gives a mechanical control of the sequence of contactor operation and obviates the necessity for fitting electric interlocks which, with solenoid operation, are numerous and deal with appreciable currents in highly inductive circuits. The adoption of an electrically driven camshaft has eliminated a serious source of trouble in regard to both maintenance cost and reliability. None of the contactors break current, except the two which have to deal with the comparatively small current during transition from series to parallel. These contactors are fitted with blow-outs. The reduction in the number of current-breaking contactors makes the whole equipment compact and is another factor in reducing maintenance.

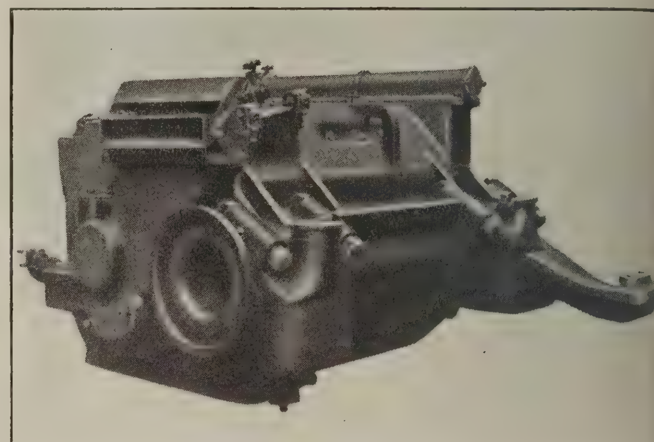


Camshaft Contactor Group No. 2 with Blow-Out on Transition Contactor Lifted for Inspection of Contacts

The camshaft provides six notches in series, five notches in parallel and one field tap notch, and is arranged in two groups, both groups being driven by a single camshaft motor. The camshaft groups consist of a number of steel cams which are mounted on a mica-insulated steel shaft. The cams are set at different angles, and each one in its turn closes a contactor. These contactors regulate the amount of starting resistance in the main circuit and also determine the grouping of the main motors. The progression of the camshaft is entirely mechanical so that no electrical interlocking is required to prevent the contactors closing in the wrong order; the progression is definitely determined and there is no possibility whatever of incorrect operation.

Interlocks

The only two electrical interlocks on the equipment are an interlock on the reversers, which prevents the line breakers closing unless the reversers are in the correct position as determined by the master controller, and an interlock on the line breakers, so arranged that the camshaft cannot begin to rotate in a forward direction until the line breakers have closed, or backwards until the line breakers have opened. By reason of this latter interlock the main circuit is always made and broken on the line breakers alone, and the resistance contactors on the camshaft require neither blow-outs nor arc shields. Both line breakers and circuit breakers are of the "English Electric" standard types and are fitted with a metallic shield blow-out. A feature of the control system is that the control circuits are protected entirely by the main control fuse and separate fuses on each circuit are dispensed with. This has the important advantage of reducing the number of delays that otherwise occur from no other cause



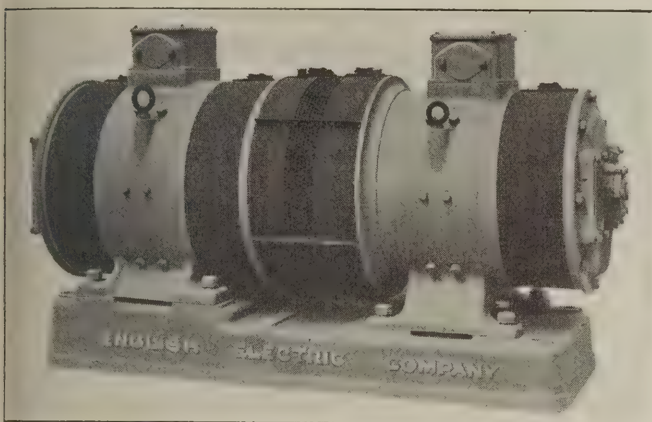
Commutator End of One of the Driving Motors Showing Ventilating Valves for Use on Flooded Track

Typical Double Track Structure

than blown fuses. The general construction of the equipment throughout is of the mica and metal principle.

High-tension Chamber

The whole of the control gear is housed in a special high-tension chamber in each motor coach. This high-tension chamber is divided into three compartments; the main compartment contains the camshaft groups, reverser, motor cut-out switch, circuit breaker, line breakers and motor generator set. The greater part of one side is taken up by the second compartment which contains the main accelerating resistances and the starting and permanent resistances for the motor generator set and exhauster motor. This compartment is separated from the main compartment by means of a panel which is bolted in place. The third compartment contains the pantograph isolating links, main isolating switch, auxiliary circuit breakers for the motor generator set and exhaust motor, reverse current relay, L. T. contactor, etc. This latter compartment is fitted with a door interlocked with the main isolating switch, as is also the door of the main compartment. The main isolating switch has three positions, a closed position, an open position and an earth position. The closed position is the normal running position. In the open position the high-tension current is cut off from the power circuits and everything in the main chamber is isolated from the high-tension with the exception of the motor terminals of the motor generator set. In this position the main door is unlocked and it is possible to enter the high-tension chamber. Control current being available, the controls may be tried and their operation examined. In the third position of the main isolating switch, the pantographs and the whole of the equipment becomes dead, the door leading to the auxiliary high-tension compartment is unlocked and the whole of the apparatus open to inspection.



The 5.7-kw. Motor-Generator Set Used for the Operation of Control Equipment

In order to prevent a dead short circuit on the line, the pantograph operating mechanism is interlocked with the main isolating switch, so that this switch cannot be placed in the earth position until both pantographs are lowered.

Pantographs

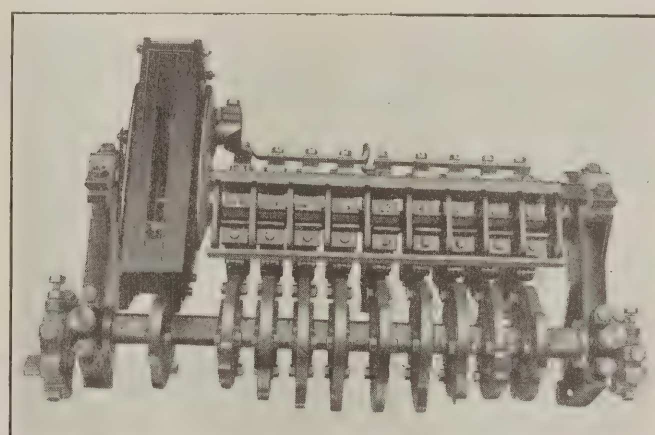
There are two pantographs fitted to each coach, vacuum operated and controlled by an electro-vacuum valve. It is thus possible for the driver to lower all the pantographs simultaneously from his driving cab. Each pantograph further has a hand-operated cock on the vacuum supply, so that it is possible to use either one or the other or both pantographs on any one motor coach. The pantographs, which are shown in one of the illustrations, are fitted with ball bearings throughout. These ball bearings, together with a special cam which regulates the leverage of the springs, ensure that there is an extremely small variation of pressure over the whole working range.

Motor Generator Set

The motor generator set, which is also illustrated, consists of a 1,500-volt compound wound motor driving a 5.7 kw. 120-volt compound-wound generator. In normal operation the generator in the leading train unit supplies the current for operating the whole of the controls of the train, and the lighting and ventilating circuits of the leading unit, the generators in the other units supplying the lighting and ventilating circuits of their respective units only. The overload capacity of each motor generator set is sufficient to allow one set to supply the current for two train units in case of an emergency. Two low-tension bus lines are fitted, and are so arranged that it is impossible to couple two motor generator sets in parallel, but at the same time allowing for the circuits on any unit being supplied from the motor generator set in an adjacent unit merely by throwing over a switch.

Braking

The vacuum brakes, which work on the single train pipe system, have been supplied by the Consolidated Brake and Engineering Company, Limited. A special electro-vacuum valve is fitted to cut the exhauster off from the train pipe when the brakes are being applied, thus ensuring an even application of the brakes throughout the length of the train. The exhauster is of the Reavell rotary type, driven by 1,500-volt series wound motor. Normally the exhauster runs continuously at half speed, but on the driver's brake being placed in the release position, the motor is speeded up to full speed, so that the normal vacuum of 20 in. can be restored throughout the train in ten seconds.



Camshaft Contactor Group No. 1 with Blow-Out on Transition Contactor in Place

Asbestos Flooring and Panels

The extensive employment of asbestos products provides significant commentary on their growing recognition in present day practice. On the Indian railways

questions of comfort and cleanliness are of necessity emphasized by climatic extremes. The adoption of asbestos, as manufactured by Bell's United Asbestos Company, Limited, in the construction of no fewer than 77 vehicles, is a measure particularly adapted to the requirements of natural conditions. Apart from its heat insulating qualities, asbestos flooring very considerably minimizes risk of fire. In conjunction with steel framing and asbestos panelling, "Decolite" flooring is stated to render rolling stock virtually fireproof, while a non-slipping surface and resilient tread are added advantages gained by its use in corridor coaches. For the intermediate lining of the walls and roofs "Salamander," flexible air-cell millboard is supplied. It is specially treated to resist the moisture of the Indian monsoon.

Care of Headlight Equipment

The following ideas on the subject of headlight maintenance were taken from an article which appeared in the Mechanical Department Bulletin of the Kansas City Southern. Practice doubtless differs on various roads, but according to J. H. Burnett, traveling electrician, who is responsible for the article mentioned, the proper procedure is as follows:

Inspection

On arrival at each terminal the entire headlight equipment should be given a thorough inspection while engine is still hot, with not less than 125 pounds of steam.

First, examine oil cups, drain off any water that may be in them, and apply oil if necessary.

Second, start turbo-generator and with all lights on take a voltmeter reading, which should read 32 volts.

Third, with no load or all lights off, take another reading which should read 32 volts. If a variation of more than 2 volts is found, the governor should be adjusted.

Adjusting Governor

This is accomplished by first adjusting the governor valve, then by adjusting the governor screws on the face of the turbine wheel until the proper voltage is obtained. When adjusting the governor screws care should be taken that each screw is turned an equal amount. Turning the screws to the right will increase the voltage, and turning them to the left will decrease it.

It is very important that the voltage be kept as near uniform as possible, especially on the engines equipped with automatic train control, as a variation of 5 or 6 volts will cause an automatic application of the brakes. A ground will also cause an application of the brakes.

To test for a ground, use a voltmeter connecting one wire of the meter to one terminal of the generator and the other wire to the frame of the generator or any metal part of the engine. Then test from the other terminal of the generator in the same manner.

Valve Adjustment

As wear takes place in the governor valve the speed of the unit and the voltage will increase, causing the light to brighten and possibly burn out. When properly adjusted the top of the governor valve will be flush with the top of the cage. Before replacing the governor valve cap pour a little engine oil on the valve.

Inspection of the governor valve should be made at least every two weeks and not wait for the lights to burn out or cause a failure of the train control. If this is done and the voltage is kept uniform the cab lights should burn approximately 1,000 hours and the headlight 500 hours.

To Focus Headlight

Throw the light from the reflector upon a wall or the end of a car about fifty or seventy-five feet distant, adjusting the focusing device until a perfect light circle is obtained. The light is in focus when the light circle is reduced to its smallest possible size by movement of the lamp forward and backward. The light beam should center on level, straight track, and should be directed to detect an object as large as a man at about 1,500 feet. If the beam is not centered the headlight should be moved to right or left or up or down as the particular case may require.

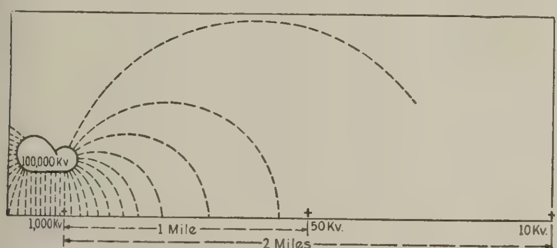
The New and Old in Transportation in Turkey

A Study of the Causes of Lightning

Production of Artificial Lightning an Important Step in Safeguarding Against the Natural Phenomena

By J. W. Peek, Jr.
Consulting Engineer, General Electric Co., Pittsfield, Mass.

A LIGHTNING stroke is generally thought of as a local but severe high voltage discharge from some cloud. As a matter of fact, the electric energy that nanifests itself in the flash is, the moment previous to the lash, stored in the surrounding air for a considerable disance. A certain small part of this energy is stored in the ir immediately around the observer, and a small induced urrent may flow in the body of even a distant observer /hen a flash occurs. The thundercloud acts as one plate f a huge condenser, the earth as the other, while the



howing How an Induced Current May Pass Through the Body of an Observer Even at Some Distance

ntervening air is the insulation. When the voltage beveen earth and cloud becomes high enough, this insulaon breaks down and the energy is dissipated in the short rcuit or lightning flash.

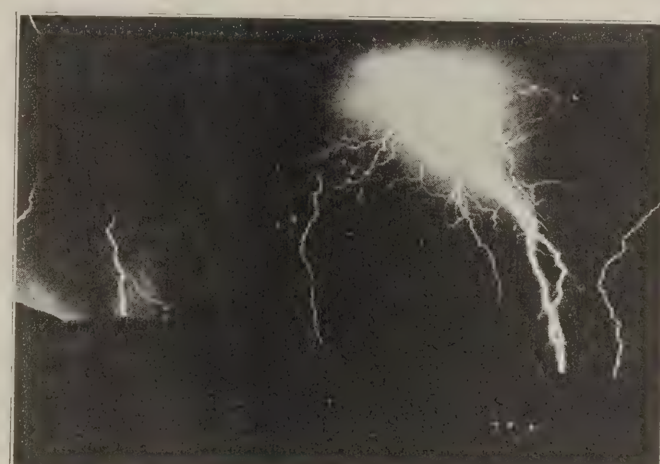
The electrical energy is changed into heat, light, sound nd chemical energy. The light is seen in the flash, while e sound is heard as thunder. Thunder is caused by r waves set up by the explosive nature of the discharge. The chemical effects of the lightning stroke are often etected by our senses in the odor of ozone that is freuently noticeable after a storm. The chemical changes ccur in the path of the discharge. The two main gases the air are nitrogen and oxygen. Each molecule of ygen is normally made up of two atoms. The electric ld tears these apart. Some of these single atoms rembine in groups of three. Oxygen with a molecule ade up in this way is called ozone. It is very active emically because the extra atom is easily detached. he nitrogen of the air is also made to combine with the ygen, producing nitrous oxide and, in the presence of por, nitric acid.

Along the discharge path are untold numbers of elecons and ions—chunks of electricity moving at enormous locities. It is possible that the ionic bombardment of e nitrogen and oxygen atoms along this path transmutes me of these atoms to helium or hydrogen. However, s is quite uncertain and speculative.

The voltage between cloud and ground previous to the scharge causes voltage between different parts of the nosphere. Right under the cloud the voltage difference r foot of air measured in a vertical direction may be ry high. In fact, a certain percentage of the lightning ltage exists between earth and any point above.

Lightning is an unorderly, predatory form of electricity, dangerous not because of its enormous energy, but because of its enormous power and "flighty" habits. The distinction between energy and power is that energy is measured in kilowatt seconds or kilowatt hours, while power is measured in kilowatts. A concrete example is always of interest. If all of the energy of a severe lighting stroke could be put into a storage battery, it would carry an electric automobile about five miles or operate an electric iron for a day. However, since this energy is dissipated in a few millionths of a second in a limited space, the effect is a terrific explosion, and the power is millions of kilowatts though the kilowatt seconds or hours are small.

A study of lightning is of considerable practical importance in providing protection against it. It is necessary to make such a study in two ways—by observation of natural lightning and its effects on buildings and transmission lines, and by observation of artificial lightning in the laboratory. By means of artificial lightning, knowledge can be gained in a few months that would require years to gain in the field. This follows because laboratory discharges can be repeated at will, while it may be necessary to wait years for a natural discharge to occur at any given place. Before artificial lightning could be produced, it was necessary to determine the nature of natural lightning. Several years were spent in measuring the voltage, the current, the frequency, the wave front, and the duration of lightning disturbances on transmission lines.



A Lightning Stroke Over the Island of Ceylon

When a thundercloud passes near or over a pole line, the air between the cloud and line is under an electric stress. The greater the distance above ground, the greater the voltage or stress. The line is said to be charged. It is a "bound charge," however, and held fast by the cloud. Nothing much happens until the voltage becomes high enough to cause a breakdown, or lightning bolt to some other cloud or to ground. The "bound charge" is set free

and waves of voltage and current pass over the line at the velocity of light, or 186,000 miles per second. This is called an induced voltage, and lightning has not struck the line in producing it. As the wave passes along, the line voltage is applied to insulators and finally to transformers or arrester gaps at an extremely rapid rate. Fortunately, leakage or corona losses help reduce the voltage as the wave travels along, but on reaching an open ended line, the voltage almost doubles as does a water wave when it strikes a sea wall. Most lightning disturbances on pole lines occur by induction with the actual flash hundreds or thousands of feet away. The line may occasionally be struck. When a direct stroke does occur, the disturbance is very severe.

The induced voltage that occurs on a line depends upon the potential of the electrified air in which the line is located at the instant before the flash. It is a certain percentage of the lightning flash, the actual percentage depending upon the position of the cloud in relation to the line. During any storm there are many disturbances at low voltage, a lesser number at higher voltage, and finally very few in a year at very high voltage. Voltages of 500,000 to 1,500,000 and higher have been observed on lines.

The field study of lightning has been supplemented by

Lightning As an Unorderly Form of Electricity

a laboratory study with artificial lightning. The artificial lightning is produced by a lightning generator. This generator, which was first built for lower voltages some years ago, has been extended to produce voltages of 2,000,000 above ground or higher than most voltages induced in transmission lines. The discharge is explosive and the power is of the order of millions of kilowatts for a few millionths of a second. Currents as high as 10,000 amperes have been obtained. The voltage increases at the rate of millions of volts per second. In common with natural lightning, artificial lightning has the following characteristics: Large wooden posts can be split and blown apart; metal can be "punctured." When a sandy spot is struck, a tube of sand fused into "glass," with tree-like branches, is produced. Such tubes are called fulgurites. Because of the explosive nature of lightning some quite unexpected phenomena frequently happen.

The lightning generator consists of high capacity condensers just as in the case of the clouds, only the insulation is glass and it is relatively more compact. As in the case of the cloud-lightning, the electricity is stored at a

This Tree Tried to Carry an Overload

relatively slow rate and discharged at an enormously rapid rate in a few millionths of a second.

The lightning generator has been of considerable help in gaining a knowledge of natural lightning. In fact, it has afforded a means of estimating the voltage of a real lightning stroke. The method was very simple. The voltage of a real lightning stroke cannot be directly measured by placing a meter between cloud and earth. However, for any given flash, the voltage induced on a transmission line can be measured. The length of the flash and cloud arrangement with reference to the line can be closely estimated. A model cloud and line were constructed to scale for a case where the measured voltage on the real line was 1,000,000 volts. Discharges were produced on the model from the lightning generator. The voltage on the model cloud could be measured as well as the induced voltage on the model line. It was found that, under these conditions, 1 per cent of the lightning was induced on the line. If the 1,000,000 induced on the real line was 1 per cent of the lightning voltage, the voltage of the flash must have been 100 times 1,000,000 or 100,000,000 volts. Of course, lightning volts vary, but this gives a good idea of the order of a severe lightning stroke. It is estimated that the current was about 80,000 amperes, and the energy 13,000 kilowatt seconds or 3.6 kilowatt hours.

The lightning generator offers a means of finding the best insulations to withstand lightning as well as the best way to design transformers, insulators, and lightning arresters.

A wire parallel to the line and connected to earth at each tower is sometimes used on transmission lines. The value of this "ground" wire has been determined by measuring the voltage induced from a model cloud on a model line with and without ground wires. It was found that a favorably installed ground wire reduces the lightning voltage on transmission lines from one-half to one-fourth of the value without ground wires. The investigation of the ground wire is a good example of the value of combining field work and laboratory work. Reports on operating experience with the ground wire after many years are conflicting. About half of the reports are favorable, while the other half express doubt as to its value. Tests on models show that the ground wire gives good protection when favorably installed, but little protection if unfavorably installed. This seems to explain the conflicting experience in practice. The line insulator ring shield and the transformer shield have a similar action and prevent high local voltages. It is possible to design line insulators and bushings with very high lightning breakdown voltages, and arrester gaps with low lightning breakdown voltages.

First Electric Locomotive Completed for the Virginian

The first electric locomotive for the Virginian Railway has been completed and on May 14 a number of preliminary tests were made on the test track of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa. Inasmuch as this locomotive is by far the most powerful ever built, the occasion was one of great interest and a large delegation of prominent railway officers from the Pennsylvania, Baltimore & Ohio, Pittsburgh & Lake Erie as well as from the Virginian Railway were present to witness the test and inspect this new electric giant.

The First Virginian Electric Locomotive

The most spectacular test to show the slowing down effect of regeneration was made by coupling a Mikado type locomotive of approximately 2,000 hp. to the electric locomotive and pushing the latter with one of the pantagraphs raised, thus allowing the motors from one of the units to feed power back into the line. The labored exhaust of the steam locomotive and the greatly retarded speed of the train, plainly indicated the powerful braking action of regeneration. The braking action can be very much increased by simply raising the two additional pantagraphs.

The Virginian electric locomotives are comprised of three units each. It is possible to separate these units to operate them individually if desired. It is also possible to add one additional unit to the three making a locomotive of four units in length with an output of more than 8,000 hp. The three units which are ordinarily semi-permanently connected are controlled from a single cab.

In operation on the Virginian one of these locomotives will be at the head end and one will act as a pusher on trains of 6,000 tons from Elmore to Clarks Gap. At Clarks Gap the trains will be filled out to 9,000 tons and a single locomotive will take the train down to Roanoke.

The successful operation of the Norfolk & Western locomotives has been a guiding factor in the design and construction of the Virginian locomotive, the principal difference between the two being that the latter are constructed for heavier service.

April Electrical Exports Highest for Four Years

Preliminary figures show that electrical machinery, equipment and supplies exported from the United States during April, 1925, were valued at $7,817,184, according to the electrical division of the Department of Commerce. This is nearly $400,000 more than for the same month of 1924, nearly $100,000 more than in March of this year, and larger than any month since June, 1921. Further, it is the first time in several years that April exports have exceeded those of March. However, mainly due to the great decrease in exports of these classes of goods during last February, as compared with February, 1924, the total for the first four months of this year is $1,401,944 less than for the same period of last year. Comparing April, 1925, with April, 1924, the shipments of generators, steam turbo units, and parts declined by about 35 per cent to $237,419, transformers of both classes decreased, the total exports being slightly over $400,000, fuses and switches decreased about 54 per cent, to $137,706.

Mechanical or Physical Characteristics of Brushes*

THE last article of this series in the May issue of the *Railway Electrical Engineer* dealt with the first of the three main divisions that can be made in a study of carbon brushes. The three divisions are: 1, Electrical characteristics; 2, Mechanical or physical characteristics; 3, Brush composition.

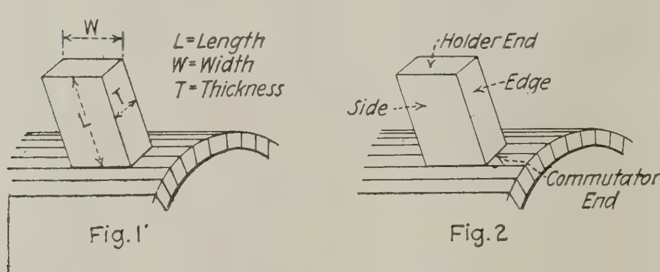
The physical characteristics of a brush can be classified as follows:

1. Size—length, width and thickness, including special shapes.
2. Attachment of shunts.
3. Coefficient of friction.
4. Hardness.
5. Strength.
6. Abrasiveness.
7. Density.
8. Thermal-conductivity.

Size of Brushes

The three dimensions of brushes, length, width and thickness, are given as shown in Fig. 1. In order to avoid any misunderstanding in designating the different faces of a brush, the nomenclature shown in Fig. 2 has also been adopted.

There are no general characteristics that govern the size



Names and Symbols of Various Brush Dimensions.

of a brush on an electrical machine. A brush usually covers more than one commutator segment and on many machines covers three or more segments. The size of brush, however, is a factor of the design and depends upon the designer's idea of the proper proportions based upon his practical experience.

Attachment of Shunts

Shunts are attached to brushes to carry the major part or preferably all of the current collected by the brushes. The use of shunts is imperative with all brushes except those intended for clamp type holders or where other means of carrying the current from the brush to the holder circuit is provided. If shunts are not used the current passes through the brush holder or through the brush pressure spring and arcing takes place, which damages not only the brush but the holder and pressure spring as well.

Shunts are attached to brushes in several ways, but in general by two distinct methods: first, independent shunts, bolted or screwed to the brush, and second, shunts permanently attached by means of solder and spun rivets and shunts cemented or packed into holes drilled in the brush. Because of the electrical and mechanical disadvantages of independent shunts this method of connection is practically obsolete. In most cases with the permanently attached shunts the connection is timed to make doubly sure of a good electrical connection.

Coefficient of Friction

The figures for coefficient of friction are abstract figures which, when multiplied by the peripheral speed of the commutator in feet per minute and the total pressure on all the brushes in pounds, and this product divided by 33,000, will give the brush friction lost on the machine in horsepower. The coefficient of friction varies on different machines under similar conditions of operation, and it also varies with the same brush on a commutator undergoing commutation and on a slip ring where no commutation is present since even atmospheric conditions have a marked influence on the figures obtained. Because of this variation, brush engineers have decided to divide the different grades of brushes into three classes: those with a high coefficient, those with a medium coefficient, and those with a low coefficient of friction. A brush falling into any one of these classes has its advantages and disadvantages and also its proper place of application. In general, a brush with a high coefficient should not be used on high peripheral speeds since the loss of power and heat generated is great. Very low friction brushes are now being made which operate economically at even the highest peripheral speeds experienced in turbo generator operation. A high friction brush finds application on low speed machines with flush mica where there is a tendency toward high mica or where a cleaning action is desirable. Coefficient of friction of brushes varies from nearly zero to above 0.65. This great variation is due to the characteristics of the materials from which the brushes are made, as well as the processes of manufacture.

Hardness

The hardness of a brush is taken with a delicate instrument called a scleroscope, in which a steel weight having a diamond point falls from a constant height and then rebounds up a graduated scale, the height of the rebound being recorded. There is no absolute unit of hardness, and the scleroscope readings obtained are relative figures which are useful only for the purpose of comparison. The following table gives a comparison between the scleroscope figures and the degree of hardness:

Scleroscope	Degrees
0—15	Very soft
16—30	Soft
31—45	Medium
46—60	Hard
61—75	Very hard

In carbon, graphite and carbon-graphite brushes the hardness is usually indicative of the strength of the brush. A hard brush is usually the strongest, but has a greater tendency to chip than a medium-hard brush. However, by the use of special processes of manufacture it is possible to make even the hardest brushes very tough.

Strength

The figures for transverse strength are determined by a breaking test. This is made on specimens of uniform size on an especially designed machine. The test piece is supported on two knife edges and a third knife edge

* From a bulletin issued by the National Carbon Co.

presses on the middle. A weight moved along a graduated lever arm increases the pressure until the piece breaks. This force is computed in pounds per square inch. Upon the strength of the brush depends its ability to withstand the mechanical stresses to which the brush is subjected. These stresses are very severe on mill, crane and railway motors, and it is only a strong brush that will meet the requirements. Strength in a brush is also desirable when used in a box type holder since the spring hammer has a tendency to wear and chip the top of the brush. With some of the softer brushes a metal clip is placed on the brush to eliminate this wear. This is particularly true of the graphite and carbon-graphite brushes of the softer grades.

Abrasiveness

The abrasive action of a brush depends largely upon the composition of the ash which forms a part of the brush. The amount of ash can be determined by heating the brush in a special furnace to a temperature which will burn out all of the carbon. Silica, mica and carborundum form the major part of the abrasive material found in the ash of carbon brushes. In general we may say that an abrasive brush should be used where the mica between the commutator segments is very hard and is not undercut or where excessive reactance voltage creates a serious tendency toward high mica. An abrasive brush will keep the mica level with the commutator and will prevent the sparking and chattering due to high mica. Except in cases where there is a tendency toward high mica or heavy sparking which roughens the commutator, pronounced abrasive qualities in a brush are undesirable. Many people are under the impression that a hard brush is abrasive and that soft brushes are not. This is not necessarily true, since hard brushes are now manufactured which are strictly non-abrasive, while some of the softer grades possess appreciable abrasive characteristics.

Density—Real and Apparent

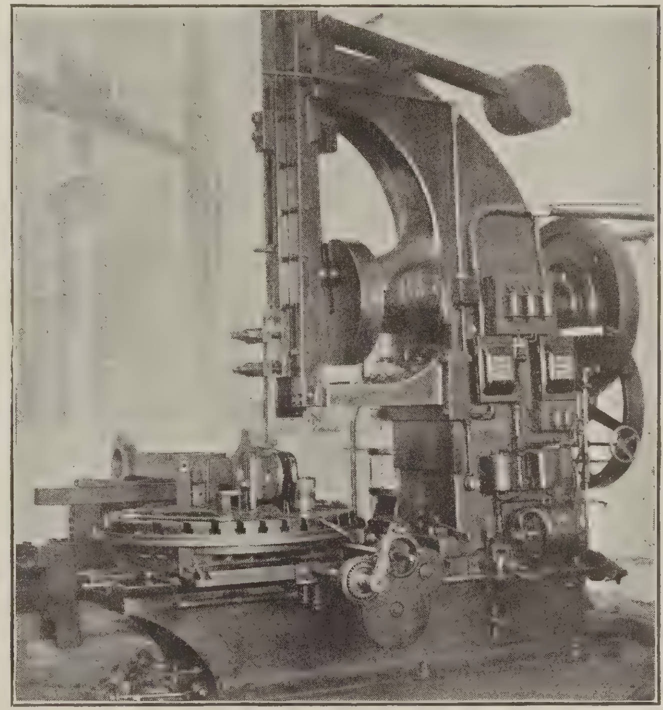
The real density of a brush is the weight of the carbon exclusive of the pores compared to the weight of an equal volume of water. The average real density of brushes is approximately 2.00. The apparent density is the weight of the carbon with the pores compared to the weight of an equal volume of water. The average apparent density of brushes is approximately 1.5. The average pore space in brushes amounts to 25 per cent. A low density brush, because of its low inertia, will more readily follow the irregularities of the rotating element, and for this reason this type of brush is particularly adapted to very high peripheral speeds.

Thermal Conductivity

There is no practical unit of measurement of this characteristic, but it is possible to determine the relative thermal conductivity of different grades. Graphite has a higher thermal conductivity than most forms of carbon, consequently graphite brushes will conduct the heat generated at the brush face to the holder and frame more readily than will the carbon brushes of corresponding density. In case it is possible to replace a carbon brush with a graphite brush having similar characteristics on a machine in which the temperature runs too high, a reduction of several degres in temperature can be effected by making the change.

A Machine Tool Drive in a Modern Railway Shop

The equipment in locomotive and car repair shops is often unjustly criticized as being out of date and not in conformity with the latest practice in manufacturing industries. While railway shops, as a general rule, are not designed for large scale production, still it is evident from the accompanying illustration, which shows a Sellers 72-in. slotter, machining a locomotive side rod in the Aurora, Ill., shops of the Chicago, Burlington & Quincy, that modern direct-connected motor drives are in service. This machine, the control equipment of which is typical of present installations of d.c. motor drives on this road, is equipped with two motors and to speed up the operation is designed to allow a rapid motor traverse of carriages and table.



A 72-In. Slotter with Rapid Motor Traverse of Carriage and Table Machining Locomotive Side Rod

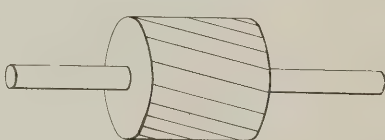
An ideal mounting for the switches and control equipment is realized by utilizing the side of the heavy machine frame. Each motor has its own safety switch, master controller and accelerating contactors. Complete speed control of the vertical carriage is obtained by turning the hand wheel which projects from the rear of the machine; operation of this hand wheel controls the speed by shifting the position of the armature with respect to the field poles. A snap switch controlling the drop light and a handy receptacle for a trouble lamp are conveniently located alongside the motor control equipment.

Out of every five letters received at the Dead Letter Office a clue is found in one and it is sent on its way to one of the two persons most interested in it. The other four are destroyed. Every person knows his own address and if put on the envelope the letter would be returned.

Locating Trouble In Stator Windings

By E. A. Thurmond, Electrician Norfolk Southern Railway

Trouble in the stator windings of large a.c. motors is not always easy to locate by mere inspection. In fact in most cases it may be said that it is hard to locate. At the same time it is important to be able to find such trouble with the least amount of work, as much time and labor



An Armature of a Small A. C. Fan Motor Locates the Trouble

may be lost in taking out many coils in search of the seat of the difficulty, unless some dependable method for finding the defective part is known.

A very handy way of locating trouble of this nature is to use the rotor of a small a.c. fan motor to point out the place where the difficulty exists. The stator to be tested is connected to a source alternating current and half normal voltage is applied to it. The small rotor is held in the hands by the shaft so that it can involve in the fingers. The rotor is placed about ½-in. from the wedge and carried all around the inside of the stator. Under these conditions the rotor will run at a very high speed so long as it is in the field of windings which are functioning properly. As soon as the defective part is reached, however, the rotor will indicate the location of the trouble by ceasing to revolve.

The method of testing is simple enough, but it will save taking out many coils to find the trouble by some other means.

Stencil Marking on Glass

Occasionally it is necessary to paint figures on glass doors or other apparatus. In order to make a neat and attractive job, it is necessary to make an outline of the characters desired and then fill in, in paint. The difficult part of the task is to obtain the clear outline. However, the problem is somewhat simplified if a piece of carbon paper is placed next to the glass with a stencil and the required characters on top. Then with a smooth round-pointed pencil, the stencil may be outlined. Upon removing the carbon paper a clear clean cut combination of lines forming the figures will appear on the surface of the glass.

Another Method of Operating Bell Circuits

By A. H. Matthews, Electrician Canadian National Railways

In the May issue of the *Railway Electrical Engineer,* I saw a diagram of connections for operating bells for car lighting batteries. As was stated, this works very well,

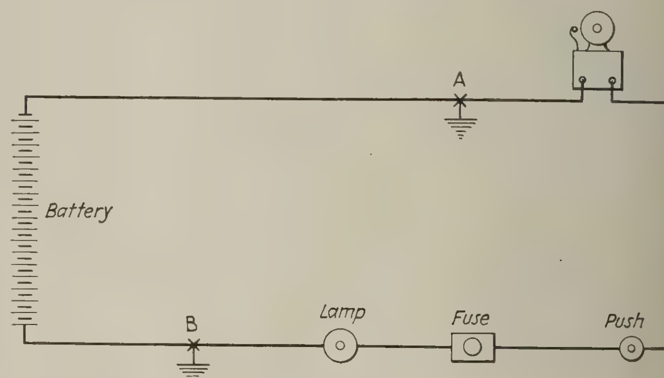


Fig. 1

but I think the following method is something of an improvement.

In cases where the bell wiring is small, such as No. 18, cotton covered wire, the wiring diagrams shown in Fig. 1

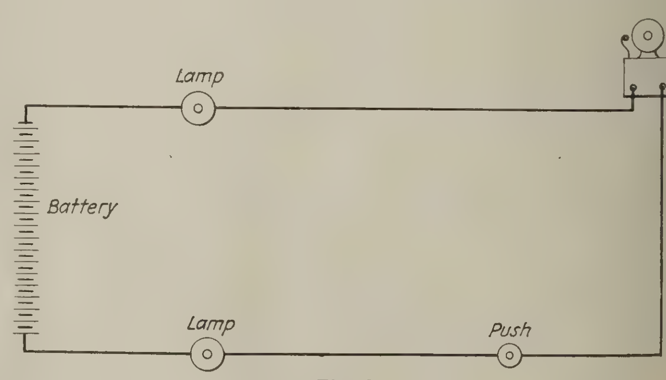


Fig. 2

has proved dangerous and several fires have been caused by the wire becoming grounded at *A*. If the battery wire at *B* is also grounded, a large current would flow in the

wire causing it to become red hot. This can happen on the road or when on charge. Of course, if proper size fuses are installed on both sides of the circuit, it would be safe, but there is the danger that the fuses will be changed for larger ones. To prevent this, I have designed a safety system which works very well and is fool proof. This is shown in Fig. 2. It consists of two lamps in the circuit,

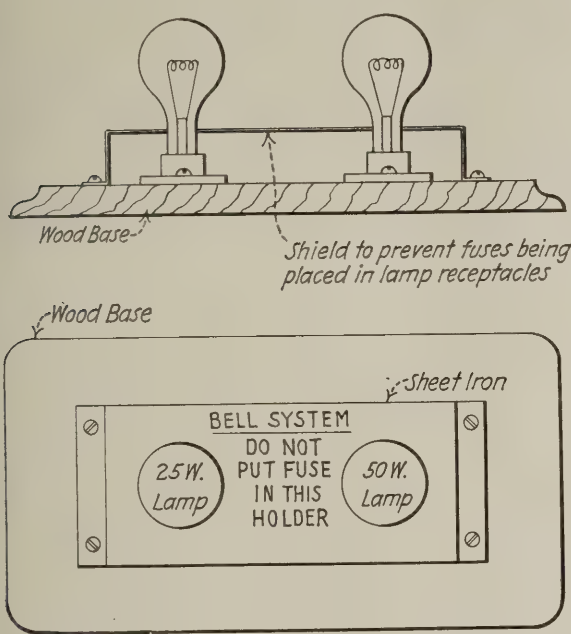


Fig. 3

one in each lead, so that in event of a ground or short only the lamp will light up, and the resistance of the lamp will prevent harmful results. The current passing through the lamp system is not heavy enough to injure the bell or the wiring. The construction details are shown in Fig. 3. Several sizes of lamps should be tried until the right sizes to fit the particular bell are obtained. The sizes of the lamps range from 15 watts to 75 watts.

Impossible

A conductor recently discovered a gentleman enjoying a cigar while riding on his car.

"You should not smoke, sir," he began.

"Indeed! That's what my friends say."

"You understand me, sir," returned the conductor, "you must not smoke."

"So my doctor tells me," responded the other.

The conductor was rapidly losing his temper, and assuming the most severe attitude he could command, he roared: "But it's against the regulations, and you shan't smoke, sir!"

"Dear me!" exclaimed the unmovèd offender, in grave tones, "That's my wife to a tee!"

Be Yourself

I

Whoever you are or wherever you're at,
Be a man or a mouse or a long-tailed rat;
Be, today, what you are—just sort o' live true—
For most folks have pegged—as *you*.

II

This does not mean you can't commence
To curtail a lot of crude offense
Against convention's edicts strict
With which your bone head plays conflict.
It does not mean you have to *stay*
A *Rube*, because you ran away
From a motley, rural, vernal crew
Who flourished where the burdocks grew.
It does not mean that manners tough
That go with a neck that's red and rough
Cannot be stepped on and subdued
To where less coarseness you'll exude.
It does not mean you can't expand
'Til you "*Savvy*" life and understand

That to get out from the common groove
You must first learn and then improve.
While in this transition be a mouse
Steal crumbs of knowledge—thru the house—
And when you reach your little nest
Cull out the bad and keep the best.
Before you brag, swell up or burst,
Be all you claim and "get *there* first,"
Or, somewhere in this hectic land,
Some bird will call your little hand.

III

On the other hand, cut out the slush;
Don't kid yourself and don't four-flush;
Don't fear to ask some goof who knows,
And who some inclination shows
To straighten out some little kink
That's put your thinker on the blink.
Remember, too, there is no doubt
That a lot of folks still ride about
In a flivver old—all full of dents—
With a name plate—reading—"Common Sense,"
When Ego toots and tries to pass
They hold the road and give her gas.
When you just feel like babbling dirt;
That nasty kind that's meant to hurt;
First, ask yourself if it is true
And will it help this thing called *you*,
Or is there any reason why
That you should pan this absent guy?
When this goes through your little bean
You'll shift and broadcast stuff that's clean.
Just play the game as best you can—
It's a good safe bet to be a *man*..

IV

The intentions of this homely screed
Are not aimed at our homely breed
Alone, because they fit as well
To other birds in the personnel.
But homely truths ofttimes have worth
In keeping clay feet on the earth.
So whoever you are or wherever you're at,
Be a man or a mouse or a long-tailed rat;
Be, today, what you are; to yourself be true,
For life has you pegged and you are *you*.

THE QUESTION CORNER

Answers to Questions

1. *How can an electrolytic rectifier be constructed?*

A Home Made Electrolytic Rectifier

For those who wish to build a rectifier for changing alternating into direct current for the purpose of charging storage batteries, there is no type of rectifier so easily constructed as the electrolytic. There are a number of ways in which this can be done, but they all depend upon the same fundamental principles.

The first requirement is four jars. These may be of glass or earthenware. A good size of jar is one which

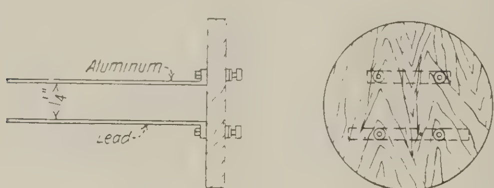


Fig. 1

is about 5 in. in diameter and 6 in. deep. The exact size is not so important but it is necessary to radiate the heat which is developed from chemical action and therefore the jars should not be too small. These jars should be fitted with wooden tops and to these tops are fastened the plates which are necessary for the operation of the rectifier. If you are able to secure jars of the size indicated, the next step is to prepare the lead and aluminum plates which are required in the cell. Four pieces or strips of lead about 1/16 in. thick, about 4 in. wide and 6 in. long are cut and four strips of aluminum about 3 in. wide and 6 in. long are likewise prepared. If you cannot secure

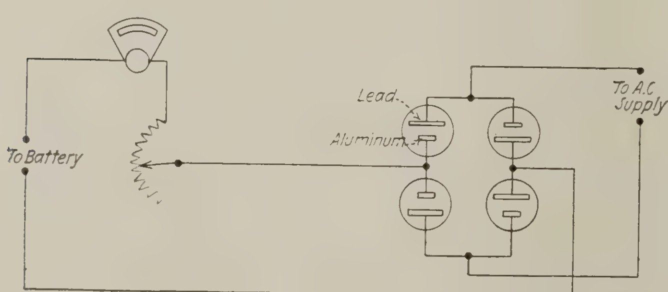


Fig. 2

jars of the size mentioned make your strips of metal of such size as to be in proportion to the jar used. If the metal is thin, it may be cut with tin shears, but if heavy it may have to be cut with a hacksaw. Old lead pipe between 1 in. and 1½ in. in diameter, if cut open and flattened out will serve for the lead plate.

To secure the strips to the covers bend one of the ends of each strip about ½ in. at right angles with the rest of the strip and then with binding posts fasten one lead and one aluminum strip on each cover. The assembled cover should appear somewhat like Fig. 1.

The electrolyte used in the jar is a saturated solution of ammonium phosphate in pure water. Such a solution requires approximately 1 lb. of phosphate to a gallon of water. This is thoroughly stirred until no sediment remains in the bottom. Paraffin oil can be floated on the top of the solution and this will help to prevent evaporation. When the four jars have been constructed in the manner described, they are ready for assembly in a tray or container of wood.

The connections for the electrolytic rectifier are shown in Fig. 2. In this illustration an ammeter and a rheostat are shown. The rheostat should be of such size as to handle five amperes at 100 volts. The connection of the alternating current circuit is shown on the right side and the connection of the battery is shown on the left. Construction details may be made in any way that the builder desires, so long as the fundamental principles are the same. The connections between the cells are made of No. 14 or No. 16 rubber covered wire. Larger wire than this is not necessary.

Before connecting up the rectifier for actual work, it is necessary to form the aluminum plates as otherwise the device would have the effect of a short circuiting a. c. line. This forming process can be done by connecting the rheostat in series with the a. c. leads of the rectifier. The ammeter should also be in the circuit as shown in Fig. 3. First cut out a fairly large part of the rheostat and close the a. c. circuit. Current will flow but will gradually die down to almost zero, cut out more resistance and repeat. This process is repeated until all of the resist-

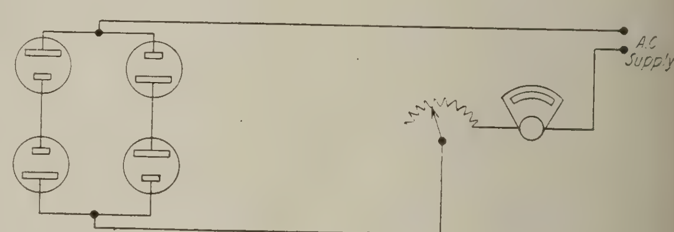


Fig. 3

ance has been cut out and the rectifier will not pass any appreciable amount of current. When this condition is obtained, the plates are formed.

It is well to mark the wires coming from the rectifier to the battery so that no mistake may be made. The positive wire is the one which is connected to the aluminum plates on the output side as shown in Fig. 2.

If the rectifier has been carefully made with pure aluminum and pure ammonium phosphate it will give good results. If jars of the size described have been used a current of three or four amperes can be taken from the device for many hours without undue heating. From time to time it will be found necessary to add water to make up for that lost by evaporation.

Questions for June

1. *Why is it that pure zinc will give a dry battery very long life whereas impure zinc will give a short life?*

2. *What happens when the plates of a battery sulphate and what causes this sulphation?*

3. *How can you tell when plates have become sulphated and what should be done with them?*

NEW DEVICES

Across the Line Starting Switch Equipped With Thermal Relay

Where the starting current of squirrel cage and slip ing motors causes no serious line disturbance, starting witches, either manually or remotely controlled, that hrow the motor directly across the line, can be used withut the introduction of reduced voltage. To replace the rdinary fuse protected knife switch for this service, the llen-Bradley Co., Milwaukee, Wis., has produced a new

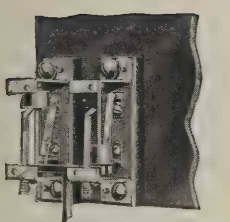


Fig. 1

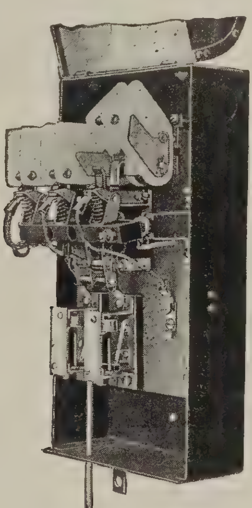


Fig. 2

ig. 1—Thermal Relay with One Contact Tripped by Overload
ig. 2—Switches for Motors Above 3-H.P. Have Arc Shields and Blowouts

arting switch known as Type J-1552 Form-T equipped ith inverse time element thermal overload relays.

This new switch, as are other remote controlled switches d starters, is operated by pressing the start button at a ush button station, which energizes the operating coil d closes the switch. The motor is thus thrown on full he voltage with the overload relays in the motor circuit. case of a severe or maintained overload, the thermal lays open the circuit of the operating coil and allow the vitch to drop open. The inverse time limit action of the lays allows momentary overloads and the normal starting current to pass without tripping the switch. The tripping current at which the relays will operate can be changed by substituting heating elements of the desired capacity. The distinctive feature of the Form-T switch is the thermal relay overload protection, which has been developed to replace the magnetic type of overload protection found on the present Type J-1552 switches. Among the important features and advantages claimed for this switch are:

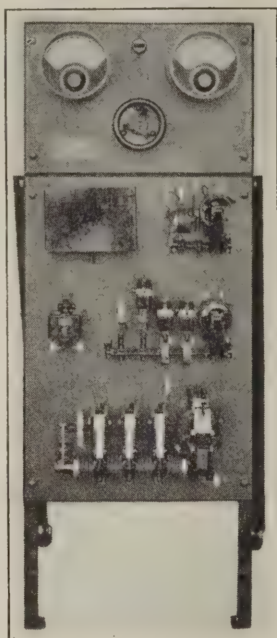
Arc shields and blowout coils on each phase of the 30 and 75-amp. sizes, and arc barriers on the 15-amp. size increase the life of the contacts. Copper to copper rolling contacts on all switches prevent freezing. A quick acting magnetic switch that closes with positive action. No voltage release protection prevents switch reclosing after it has been opened. Thermal relays protect against single phase running and sustained overload and are manually reset without opening cabinet. Resistance elements of thermal relays can be removed easily by taking out two screws. The steel cabinet may be locked as the operator can reset switch by pushing up the rod that projects from the bottom of the cabinet.

Each thermal relay is essentially a thermostat actuated in case of overload by a small heating element of the required current capacity. The heating wire or strips are mounted on a piece of asbestos composition and is connected in the motor circuit. To throw the heat generated by the motor current directly on the thermostat the heating element is mounted just in front of the thermostat, which is curved in slightly so that it normally supports a weight. This weight is otherwise free to slide down a guide rod and trip a pivoted contact bar connected in the control circuit of the switch. In case of a sustained overload the heating element raises the temperature of the thermostat until it moves back and allows the weight to drop. This opens the switch control circuit and also opens the main contactor, thus disconnecting the motor from the line. It is stated that the relay will trip before the motor overheats and yet has a considerable time lag such that its tripping curve follows the heating curve of the motor sufficiently close to avoid unnecessary tripping.

Starting switches of this type are made in capacities up to 25 h.p., 220 volts, and 35 h.p., 440 and 550 volts for squirrel cage motors. They can also be used to control the primary circuit of slip ring motors when the primary current does not exceed 75 amperes.

New Industrial Controls

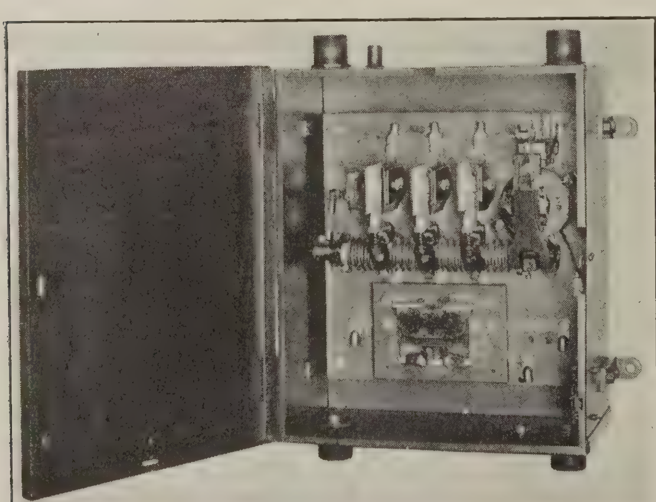
Among the recent developments in industrial control are three new types of starter now being marketed by the General Electric Company. These are an enclosed magnetic switch for starting two- and three-phase alternating-current motors, and two types of automatic starter for synchronous motors, one for full-voltage starting and the other for reduced-voltage starting.



C R 7065 HI Controller

The enclosed magnetic switch bears the designation CR-7006-D9 and is for use with two- and three-phase alternating-current motors which can be thrown directly on the line in starting. This switch is also used to handle the primary circuit of a slip ring motor in conjunction with a secondary drum switch. The CR-7006-D9 was developed for starting larger motors than can be handled by the CR-7005 and CR-7006 types of switch now on the market. Overload protection is provided by means of a relay which follows very closely the heating curves of the motor. This switch can be operated by a push button, pressure governor, float switch or similar device and, when used as a primary switch for slip ring motors, a drum switch is the only accessory needed.

The new synchronous motor starters bear the numbers CR-7065 and CR-7061, for full and reduced voltage starting, respectively. Both starters are completely automatic and provide an easy and dependable means of starting synchronous motors. Special features are a temperature overload relay for close protection of the motor from overload, a definite time relay which determines the accelerating period during which the motor is connected to the compensator taps and a field controlling relay for closing the field contactor.

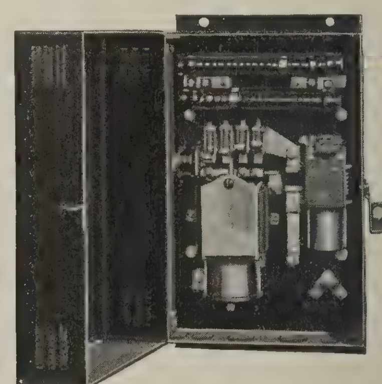


C R 7006 D 9 Magnetic Switch With Relay Cover Open

The CR-7065 starter is recommended for use with slow-speed synchronous motors driving pumps, compressors, and for other general applications. The CR-7061 starter is recommended for use with medium and high-speed synchronous motors for driving pumps, motor generators, etc.

Time Limit D. C. Automatic Starter for Small Motors

Extending its line of automatic motor starters operating on time limit acceleration to include motors under 5 h.p., the Industrial Controller Co., Milwaukee, Wis., has brought out its Class 7107 starter. This starting panel provides time limit acceleration, low voltage protection, overload protection, if desired, and remote control operation by means of a push button station, float switch, pressure regulator, etc. It has all the operating features of the larger automatic starters of the 7100 class, but its design makes it particularly compact and suitable for mounting on small machine tools, pumps, ventilating systems, etc.



Class 7107 Starter With Overload Relay

The starter consists of a solenoid with continuous duty magnet coil, a core and piston on which is mounted the contact bar for short circuiting the starting resistor and an air dash pot with valve for regulating the speed of acceleration. The contact fingers are of the sliding "butt" type with helical springs to insure proper contact pressure. The action of the solenoid and piston is in a straight vertical line and the short circuiting bar makes direct contact with the fingers without the use of cams or toggles, resulting in a simple and rugged construction. A powerful magnetic blowout is provided on the first contact finger so that this starter may, it is said, be safely used for "inching" or "jogging" service.

The resistor units are of the enamel type and are mounted on the face of the panel above the accelerating mechanism. They are readily accessible and this novel construction allows a shallower enclosing cabinet. Resistors are rated according to Electric Power Club classification No. 35. The entire starter mechanism and resistor is mounted on an ebony asbestos panel. The panel as a unit may be removed from the cabinet. This leaves the cabinet empty for the running of wires and connecting of conduit. The cabinet is made from heavy gage sheet steel, welded and enameled, fitted with a door, hinged at the side and supplied with a latch for padlock.

'he cabinet gives protection with adequate ventilation. 'he I-C, oil dash pot, overload relay is adjustable for both me and current and affords complete protection to the otor. A vibrating field relay may be supplied, but size panel does not permit both overload relay and field lay.

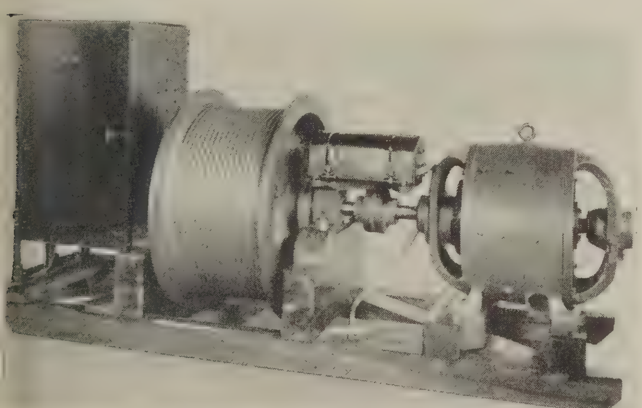
The Class 7107 d.c. automatic starter, in those sizes om ½ to 3 h.p., inclusive, has the same mounting mensions as the Class 8527 a.c. automatic starter of milar rating. The only difference in dimensions is the epth of the cabinet. The same bracket or drilling temate can be used.

As previously stated, the Class 7107 d.c. starter, hower, is built for ratings up to and including five horsepwer.

A New Electric Hoist for Skip Buckets

Greater leeway in the choice of hoisting equipment for ilway coaling stations has been afforded railroads in the evelopment of a new type of automatic hoist for use in evating skip buckets. This machine is an electricallyerated device of the reversible self-breaking type, which nsists essentially of an internally-geared drum to which te driving motor is direct-connected through a flexible upling. The arrangement of parts produces an unually compact unit.

In addition to the spur gearing, the hoisting drum incdes all the reducing mechanism for the machine, which echanism permits speed reductions from 40 to 1 and to 1. The operation of the machine is as follows: he pinion on the driving shaft of the motor negotiates



The Hoist Set Up for Shipment

th three gears located at equal intervals on its circumence. These gears mesh with an internal gear and ough this internal gear operate another set of three parate gears which are mounted on independent eccenc shafts. The eccentric action of these three gears ses a large ring gear, which meshes internally with the in driving drum, to revolve the drum at the desired ed for hoisting a load. Ordinarily the bucket operated this drum moves at a speed not to exceed 110 ft. per nute.

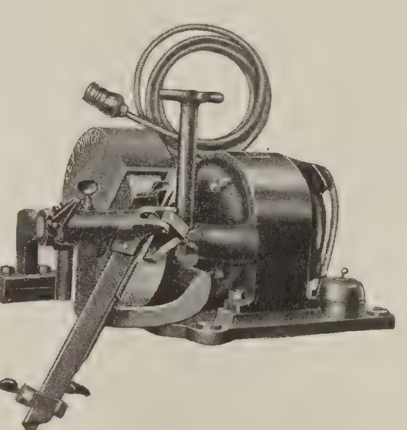
For limiting the travel of the load a Cutler-Hammer it switch, which operates on the cam principle, is unted on the hoist and this switch functions through Cutler-Hammer control for reversing the operation of hoist drum. This self-braking type of hoist avoids the expense of a solenoid brake, since the resistance to back travel through the eccentric, described above, is such as to afford a locking power sufficiently effective to prevent the load from backing up the drum when the current is cut off.

The main drum is made oil tight and all the gearing inside this drum operates in oil to reduce to a minimum the effects of friction and dirt. For reasons which are clear from the description, the machine is called a reversible enclosed self-braking automatic hoist. The electric hoist is a product of the Roberts & Schaefer Company, Chicago.

New Electric Twist Drill Grinder

A new portable electric twist drill grinder has been designed that produces efficient work at a rapid rate with unskilled workmen. This device, called the "Keypower" and manufactured by the Keystone Grinder and Manufacturing Company of Pittsburgh, Pa., is sturdy and substantial in construction.

The grinding action is produced by light pressure of the drill against the face of the grinding wheel. This light pressure method of grinding permits rapid work, and prevents burning of the steel or drawing the temper of the tool. The tool or drill is held firmly in place by means of wedge shape tool holder, that assures uniform results and eliminates the uncertainty of hand application. No



New Electric Twist Drill Grinder

water is necessary during the grinding process since there is a continuous air circulation on the face of the wheel, that cools the tool.

Railroad repair shops, yards, and construction gangs find this device particularly useful due to its portability;—the machine weighing only 60 pounds. With it they are able to grind their tools right on the job. A heavy hood over the grinding wheel gives ample protection to the operator.

This electric grinding device is driven by a Westinghouse ¼ hp. motor. An attachment cord enables the machine to be plugged into any ordinary socket. It is capable of redressing all shapes and kinds of edge tools, such as are in use in industrial plants and railways, and is fitted for grinding ¼ inch to 1½ inch drills.

The machine will thus be seen to meet a large number of requirements.

General News Section

The Western Electric Company has recently opened a supply house in Miami, Florida. The new building is located at 68 25th St., N. E., and has a floor space of 6,500 square feet.

The Interstate Commerce Commission has denied a petition filed by the Illinois Central on May 9 for a further extension of time in which to complete its installation of automatic train control.

The Interstate Commerce Commission has granted a petition of the Chicago & North Western for exemption from equipping with automatic train control devices the locomotives of its Sioux City division operating between Maple River Jct., Ia., and Carroll, three and one-half miles.

The New York, New Haven & Hartford installation of continuous train control on 20 miles of line near New Haven, Conn., including 10 locomotives, was inspected by representatives of the Interstate Commerce Commission beginning Thursday, April 16. Five engines are equipped with the apparatus of the General Railway Signal Company and five with that of the Union Switch & Signal Company.

The Interstate Commerce Commission has authorized the Chicago, Indianapolis & Louisville to install automatic train control upon its air line between Hammond and Monon, Ind., in lieu of the installation required in the commission's order of June 13, 1922, but has denied the company's petition that the order of January 14, 1924, requiring an installation upon another portion of its line be vacated.

The Okonite Company announces the formation of the Okonite-Calender Cable Company, Inc., for the manufacture of impregnated paper cables made under patents of Calender Cable & Construction Company, Ltd., of London. Machinery is being installed in a new plant at Paterson, N. J., and it is expected that production will begin by July 1. A completely equipped electrical research laboratory is one of the features of the new plant.

The Chicago, Indianapolis & Louisville installation of train control on 20 miles of single track, Rensselaer, Ind., to Shelby, was inspected by representatives of the Interstate Commerce Commission starting Tuesday, May 5. This installation of the intermittent inductive train control system of the Sprague Safety Control & Signal Corporation includes six locomotives using the permissive feature.

The Sesqui-Centennial celebration proposed to be held in Philadelphia in 1926, the 150th anniversary of the signing of the Declaration of Independence, is the subject of a pamphlet which has been issued by the Pennsylvania Railroad giving some scrips of history of the progress of that company's lines, since 1835, and assuring the citizens of Philadelphia, and the American people generally, that the railroad company aims to co-operate in the proposed celebration.

The Thompson Electric Welding Company, Lynn, Mass., has removed its Chicago office from 817 West Washington Boulevard to 549 West Washington street; this office is in charge of F. H. Leslie. The company has discontinued its connection with the English & Miller Machinery Company, Detroit, Mich., and is now represented in Michigan by James A. Muir, General Motors building, Detroit, Mich. On June 1, the Thompson Electric Welding Company discontinued the sales office in Cincinnati, Ohio, and will open a new office in the Leader building, Cleveland; C. E. Seifert and M. G. Littlefield will be located at this office. R. S. Donald, 50 Church street, New York City, represents the company in New York.

Great Northern Begins Mountain Grade Electrification

A contract for four electric locomotives and other equipment to be used in the electrification of mountain grades of the Great Northern has been closed with the Westinghouse Electric & Manufacturing Company. This electrification project, which was announced some time ago, will extend from Skykomish at sea level through the Cascade tunnel to the summit about 24 miles. The work will be undertaken immediately and it is planned for completion within 12 months. The cost is estimated at approximately $1,000,000.

The locomotive will be driven by direct current motors, which will be supplied with power through a motor-generator set, taking energy from a single-phase high voltage alternating current trolley. This is the same principle as will be used in the electric locomotives of the Detroit, Toledo & Ironton as well as in some of the locomotives recently ordered by the New York, New Haven & Hartford.

K. C. S. Asks Relief from Train Control Order

The Kansas City Southern has filed a petition with the Interstate Commerce Commission asking that it be relieved from the duty of installing automatic train control as required in the two orders issued by the commission. The time for the completion of the first installation has been extended to July 1 and the petition states that a 14-mile section has been completed for test purposes, with equipment furnished by the General Railway Signal Company.

It is stated, however, that the road is primarily a freight carrying line, having only two passenger trains each way a day, and that the risk of accident is slight. Statistics are given in support of this. It is estimated that the cost to comply with the first order would be $425,000 and a list is given of other projects for capital expenditures which should have precedence. It is also stated that the

company is not in the same class as to volume of business or financial condition with other roads in its territory that are included in the list of roads named in the commission's orders.

Long Island Extends Electrification to Babylon

Electric operation was officially begun on the Long Island Railroad between New York and Babylon on Wednesday, May 20, when a special train carrying railroad officers and visitors was run between the two terminals. To provide electric passenger train service as far as Babylon on the Montauk division has called for an expenditure of approximately $5,000,000. Authorization to electrify between Jamaica and Babylon—a distance of 28 miles was given by the board of directors in April, 1924. Work was commenced at once upon the preparation of specifications and plans for the substations, transmission lines, and distribution system and active construction was begun in June, 1924. Practically all the work was carried out by the railroad company's own forces, the undertaking being completed in less than a year. Six sub-stations have been built together with two transformer stations for increasing the transmission line voltage from 11,000 to 33,000.

Celebration at Freeport, L. I., of Beginning of Electric Train Service Between New York and Babylon

D. & H. Suit Partly Successful

The United States Court at New York City on May 26, in an opinion on the suit of the Delaware & Hudson, asking for an injunction against the Interstate Commerce Commission to forbid the enforcement of the commission's order calling for the installation of automatic train control apparatus between Whitehall, N. Y., and Rouse's Point, 131 miles, granted an injunction against any effort on the part of the government to enforce penalties, but refused the sweeping injunction asked for by the road.

The decision holds that the order of the commission is constitutional, and says that opinions concerning the value of automatic train control devices are so diverse that if the commission did not act, progress in many instances would be wholly arrested.

The court states the plaintiff's arguments under four heads: (a) constitutionality of the law; (b) the commission did not investigate this road's needs and therefore acted arbitrarily; (c) the roads are required to experiment with untried devices at their own cost; (d) the order of July 18, 1924, permitting the use of the forestalling feature was equivalent to a new order and therefore must allow two years for compliance. Discussing these points in order, the court's opinion may be summarized as follows:

(a) Congress did not delegate legislative authority; it prescribed a rule for the guidance of the commission, namely, "to install automatic train stops or other safety devices." The application of the rule consists in choosing the railroads and in laying down the requirements. Application is left to the commission.

(b) The commission did make an adequate finding of facts, though it did not mention the Delaware & Hudson by name. The court is satisfied that, in the confused state of the art, the commission's finding of facts is reasonably to be held a compliance with the law. Congress decided the matter in gross and the commission has decided the details. The commission says that what has been done during the last 15 years has demonstrated the practicability and the necessity for automatic train stops or train control. This the court holds sufficient.

(c) Congress rightfully requires the railroads to make experiments; and no experiment is possible except on the railways themselves, under actual traffic conditions. The case is parallel to the action of Congress in passing the safety appliance statutes of former years.

(d) To allow the use of a forestalling device may be equivalent to giving a road a choice of eight kinds of apparatus where previously it had a choice of only four kinds. To call such a change a mere amendment is unfair, if not absurd. The commission's opinions of 1924 frankly eat a great many of the words used in 1922.

The plaintiff, therefore, may have an injunction against prosecution for two years from July 18, 1924. In every other respect the motion for injunctive relief is denied.

Electrification of Yonkers Branch

Plans for the electrification of the Yonkers branch of the Putnam division, New York Central Railroad, were approved by an order of the Public Service Commission of New York, dated May 6. The protected type of under running third rail will be used. Power will be supplied from the substations at Mott Haven, Marble Hill and Glenwood. Plans and specifications for the proposed work must be presented for approval before any of the actual work has begun. The commission has also directed the railroad company to file by July 1, detailed plans for the electrification of the main line, Putnam division, and the Saw Mill River branch, north of the Yonkers branch.

The B. & O. Staten Island Electrification Nearing Completion

The electrification of the Staten Island Rapid Transit, the Baltimore & Ohio subsidiary on Staten Island, New York, is rapidly nearing completion. The South Beach division began operation under electric power on June 5. The Perth Amboy division will be ready for electric operation in about one month. A celebration of running the first electric train over each division will be held by the residents of the sections affected.

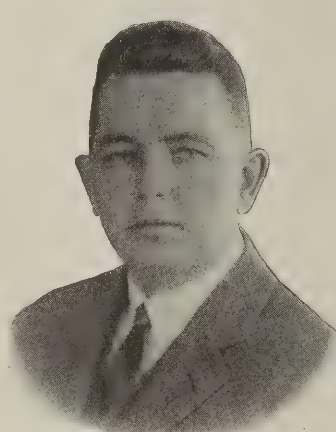
Personals

A. M. Ripley, who was recently appointed to the railway signal sales department of The Electric Storage Battery Co., with headquarters in Chicago, was formerly district representative of Northern Illinois for the company's automobile battery department.

Mr. Ripley was graduated from Northwestern Uuiversity in 1923. Upon his graduation he entered the employ of The Electric Storage Battery Co., in Chicago, Illinois. Mr. Ripley was born in Brunswick, Maine, February 16th, 1898, attended school in Chillicothe, Illinois. During his high school course he was employed by the Atchison, Topeka & Santa Fe Railway Co. in the mechanical department.
During his high school course he was employed by the Atchison, Topeka & Santa Fe Railway Co. in the mechanical department.

During the world war he served as a sergeant in the 123rd Machine Gun Battalion of the 33rd Division. After his discharge from the army, he returned to the employ of the Atchison, Topeka & Santa Fe Railway.

William H. East, whose resent appointment to the position of sales engineer, railway department, Central Electric Co., Chicago, as noted in the *Railway Electrical Engineer* for May, will cover both the steam and electric railway field in the territory east of the Mississippi river. He was born at Peoria, Ill., on November 8, 1884, and graduated in electrical engineering from the University of Missouri in 1907. Following his graduation from the latter institution he entered the service of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., as a graduate apprentice, and spent six months testing electrical equipment in various departments of that organization. His first railway experience dates from 1907, when he was employed by the Union Traction Co., Anderson, Ind., as an electrician, later being appointed division electrician of the Anderson division in charge of substation, high tension transmission, and overhead distribution construction work on about 150 miles of line. He left the electric railway field in June, 1913, to accept a position in the electrical department of the Chicago, Burlington & Quincy at Chicago. In 1917 he was appointed assistant electrical engineer of this road, serving in this capacity up until his change of connections as previously noted.



W. H. East

W. B. McGrew, who has served in the electrical department of the Illinois Central for a number of years has been appointed electrical foreman at East St. Louis succeeding Mr. Weber.

B. T. Weber, formerly division electrical foreman for the Illinois Central at East St. Louis, has been appointed general electrical foreman at the Burnside shops to fill the vacancy made by Mr. Goddard's promotion.

O. B. Chandler has been appointed sales manager of the supply distribution branch house of the Western Electric Company at Memphis, Tennessee, to succeed **E. P. McGrath,** who has been transferred to the supply distributing house at New York.

A. H. Darker, chief electrical engineer of the J. Stone & Co., Ltd., London, S. E., who has been making a long tour around the world, has recently returned to London. Mr. Darker sailed from England on January 18, 1924, traveling in an easterly direction, and returning via Canada and the United States.

G. T. Goddard, formerly general electrical foreman in the Burnside shops of the Illinois Central has been appointed equipment inspector of the Chicago terminal improvement department of the Illinois Central. Mr. Goddard will supervise the electrical inspection of motor and control equipment at the manufacturer's during its construction and also after installation.

E. R. Fulcher, formerly lead electrician of the Nashville, Chattanooga & St. Louis Railway at Nashville, Tennessee, was recently promoted to the position of assistant chief electrician with headquarters at the same place. Mr. Fulcher was born February 20, 1897, in Nashville, and finished the grammar school at the age of 15. After spending four years in private school and colleges he entered the employ of Fulcher Brothers Electrical Company. In 1917 he accepted a position with the Nashville, Chattanooga & St. Louis Railwav and in 1923 was made lead electrician, which position he held until his recent appointment.

Trade Publications

Sangamo Electric Company, Springfield, Ill., is distributing an illustrated folder entitled "The Advantage of Metered Electric Service."

The Ohio Electric & Controller Company, Cleveland, Ohio, have just issued bulletin No. 107 describing lifting magnets and discussing and illustrating their use in the iron and steel trades, also for magnetic separation of tramp iron from ore, cement, coal, etc., over conveyors or chutes. Numerous illustrations show application for handling pipe in warehouses, rails, billets, etc., as well as iron, steel and scrap in bulk.

Arc Welding and Cutting Manual is a 127-page volume, bound in cloth, recently issued by the General Electric Company. This has been given the designation Y-2007 and was issued to acquaint the uninformed in a general way with some of the applications of arc welding, and to provide a simple and logical method by which one may acquire a certain familiarity with the manipulation of the electric welding arc and its characteristics. The volume is illustrated with photographs, diagrams and charts explanatory of the text. It is divided into three parts, the first devoted to general information on arc welding, the second to a training course for operators, and the third giving a number of applications of arc welding. The manual should prove very valuable in practically all industries and trades. It is being distributed at a nominal price.

Railway Electrical Engineer

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What "Short Cuts" Are You Using?

There is no question but that many of the readers of the *Railway Electrical Engineer* are much interested in the practical side of the application of electricity to railroad work. In addition to lengthy articles on general subjects in other sections of the paper the Interchange department makes a point to publish some particular stunt or stunts which have been found of value to electrical men in their daily work. Most of them are what might be termed "home made" or perhaps more correctly "shop made" devices. In the majority of instances these shop made devices are just as applicable to one road as to another and it is with the idea of furthering their adoption that the descriptions are published. There is apparently a lack of cooperation on the part of many of our readers, in that only a few contribute to the columns which are read by the many. Too large a percentage of the practical stunts which appear in the Interchange section come from the editors. This is decidedly not as it should be. The very name Interchange indicates an exchange of ideas between the readers and this is the real aim and purpose of the column. Send us a simple description of some method or device which you have discovered to be of benefit. Usually a plain sketch or photograph will help to make clear just how the device is built. We want more of this material in the *Railway Electrical Engineer* and it should come from the readers. Have you been doing your full duty in this respect? Make it a point to send in at least one short practical stunt for the Interchange section. Don't put it off, but do it now!

Cleaning Electrical Machinery

Probably the most common way of cleaning electrical machinery is to blow out the dirt with air from the shop air line. The life of a machine is greatly extended if it is kept clean in this way. The shortcomings of this method are that the air contains some moisture which is apt to be hard on insulation and the air in itself will not remove oil and grease. Portable motor driven blowers can also be used. The blast from these machines is not as strong as that from the air line, but it will remove the loose dirt just about as effectively and no water is carried along with the air.

A spray gun is used for cleaning fields and armatures in the car lighting shops of the Central of Georgia at Savannah which will be described in a subsequent issue of the *Railway Electrical Engineer*. The gun is operated exactly as a paint spray gun except that gasoline is used instead of paint. The shop air supply is used, but no damage is done by water as the rapid evaporation of the gasoline carries all moisture with it.

Many parts of electrical machinery are in a strict sense mechanical and such parts are not injured by water. For cleaning these parts an emulsion of water in gasoline can be used. This reduces the fire hazard, lessens the cost of the cleaning solution and is extremely effective in removing dirt which contains oil, grease or tar.

Electric locomotive running gear on the Chicago, Milwaukee & St. Paul is cleaned at Deer Lodge, Montana, in a similar way, but for this work a special cleaning solution containing soap, water and kerosene is used.

This general method of cleaning saves much labor and cleans quickly and effectively parts that are otherwise inaccessible. It will probably find a relatively wide application and the problem that remains to be solved is to devise the best cleaning mixture for each application of this method. The mixture must be such that it will clean effectively without injuring the parts to be cleaned and the cost of the solution must be kept as low as possible. In addition to this the type of spray gun used should be such as to reach the parts effectively without using an unnecessary amount of air.

Electric Locomotive Efficiency

It is a generally accepted fact that electric locomotives are more efficient than steam; that their use represents a saving in fuel. Estimates of relative efficiencies vary from 40 to 80 per cent. That is, claims are made that the use of electric motive power will save from 20 to 60 per cent of the fuel bill. The actual figure is probably a compromise between these two and is governed to a certain extent by the locality and the nature of the service.

Great efforts are being made to improve both electric and steam locomotive efficiencies. The efficiency of the electric locomotive itself is very high and for this very reason is practically fixed. The efficiency of transmission and contact lines is not so high but is also practically fixed. Resistance losses can be decreased by increasing the size of conductor or increasing voltage, but there must be current and there must be wire and practical values of voltage and sizes of wire are governed by cost. Accordingly, any considerable improvement in electric locomotive efficiency must be made in the power plant. Steam locomotives are less efficient, but the designers need only copy the power plant methods and devices and adapt them to the locomotive in order to improve efficiency. They are of course hampered by space limitations and

vibration. Improving power plant efficiency means venturing into untried fields.

Strange as it may seem, during the past four years the railroads were able to reduce the coal or coal equivalent required to move one ton-mile of freight by only 13½ per cent, while the central power stations reduced the amount of coal or coal equivalent to generate one kilowatt hour by 35 per cent. In the past, steam locomotive builders have striven most for increased size and power and have endeavored to retain the utmost simplicity in design. Now they are departing from the old simple designs and are paying more attention to efficiency. The trend of these efficiencies will be interesting to follow. Will the steam locomotives start to overtake the power plants or will the power plants continue to improve their position and widen the gap?

Locomotive Availability

Electric locomotives can be kept in service a much greater percentage of the time than can steam locomotives. This is one of the more important reasons for the adoption of electric traction in congested sections and is rightfully used as an argument to influence the adoption of electric motive power. It is unfortunate that exact data on the availability of steam and electric locomotives is not to be had on the majority of railroads. Because of its importance some association may compile information on this subject, but if this is done great care must be taken to give consideration to all the different factors which enter into the problem.

In the report presented to the Mechanical Division of the American Railway Association this year by the Committee on Electric Rolling Stock, the statement is made that steam locomotives are available for service 45 per cent of the time while for electric locomotives this figure is 85 per cent. In this case the 45 per cent figure refers to time the locomotives are in condition to be used, if needed. If the figure referred to actual time in service on the road, it could be obtained from data compiled by the Interstate Commerce Commission and would be nearer 20 per cent than 45.

When an attempt is made to determine just what availability is, proper consideration should be given to all the factors that keep locomotives out of service. It is a more or less common opinion that it takes the mechanical department 55 per cent of the time to keep steam locomotives in repair and prepare them for service. As a matter of fact, the operating department is responsible for a large part of the out-of-service time. It is not possible to operate a railroad so that all locomotives are in service all of the time they are in serviceable condition. It would be the equivalent of operating a power plant at 100 per cent load factor.

Another reason for the good showing of the electric locomotive is that it is ordinarily used in congested territory where there is enough traffic to keep the locomotives in service a large part of the time. They are seldom used in places where the traffic is such that they must lie idle much of the time.

The fact remains, however, that the greater availability of the electric locomotive is a strong point in its favor. Electric locomotives on the Butte, Anaconda & Pacific are available for service 360 days out of 365, twenty-four hours a day. Steam locomotives can not hope to match this service and the important thing for the electrical man to know is just how near they can approach it. It may not be possible to determine actual availability, but in lieu of this, data covering actual time in service for similar divisions would supply the needed information, assuming, of course, that maximum use is being made of the locomotives. If a number of divisions on several railroads were selected (some steam and some electric) where traffic conditions are such as to permit intensive use of motive power, information could be obtained on time in service of each type which could be utilized and would be of real value.

Corrosion Tests of Electrical Conductors

The relative merits of various electrical conductors as regards their ability to withstand deterioration from atmospheric conditions have been strikingly brought out in a report recently presented before a meeting of the American Society for Testing Materials. In order to determine to just what extent conductors are effected by changes in the air surrounding them, a rather elaborate test was conducted on 21 different types of conductors used for electrical purposes. A test box constructed of wood was so designed as to permit the alternate introduction of warm air, humid air, coal smoke and a fine spray of water. One complete cycle consisted of passing into the box warm dry air for 3 hours, warm moist air for 1.5 hours, air charged with coal smoke for 3 hours and water spray for 0.5 hours.

At the end of approximately every 100 cycles, the wires were removed from the test box and carefully inspected, to ascertain what deterioration had taken place. As was expected, the copper and aluminum wires and strands did not show serious corrosion up to 302 cycles, and there were no marked failures at any time either in the copper clad steel or in the reinforcing wire of the aluminum cable. Little if any difference was noted between the corrosion in solid wire and stranded wire of the same grade of material. Copper centered steel strand resisted corrosion fully as well as the standard material of the same grade. It was also noted that the higher the carbon content of the galvanized wire and steel, the greater the apparent resistance to corrosion.

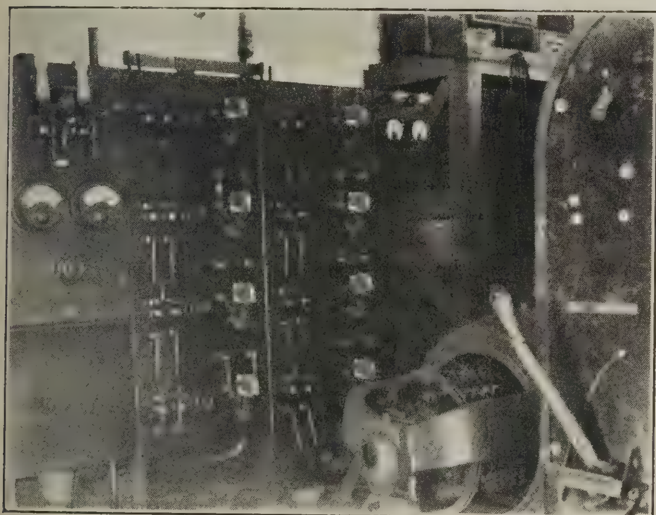
The experiment has shown that there are possibilities of pre-determining how certain electrical conductors will be affected under atmospheric conditions of a given locality and while the aggravated conditions which obtained in the corrosion box were such as to hasten the deterioration of the conductors, the relative merits of the different types are quite evident. At the present time, samples cut from the original conductors are undergoing a test in the open air in the same locality, and while this test has been run much longer than the corrosion box test, the specimens so far show practically no signs of deterioration. The results, so far obtained indicate that eventually it will be possible to equate in some manner the relation between the corrosion box test and the open air test, making it possible to predict with a fair degree of accuracy the behavior of electrical conductors under certain atmospheric conditions.

Charging Plants for Car Lighting Batteries

Conduit Laid Underground is Protected from Corrosion By Burlap and Tar

TWO yard charging plants have recently been installed on the Illinois Central at New Orleans which are of a type suitable to the great majority of railroad requirements. One is a 20 kw. plant, located at the station and the other is a 35 kw. plant located at the coach yards, about one-half mile from the station. The two plants are similar and a description of one will suffice for both.

The coach yard plant occupies one end of the battery house and the apparatus used is a motor-generator set with the necessary motor control equipment and a direct current switchboard. The motor-generator set consists of a General Electric, form B, 220-volt, 3 phase, induction motor running at 1,800 r.p.m. direct connected to a G. E. form C, 85-volt, flat-compounded, direct current generator.



Interior of Charging Plant

Alternating current power wires are brought from a pole to a Pierce bracket on one end of the building. From the bracket the leads are carried into a 2-in. F condulet, down the wall in rigid metal conduit and through the wall with the aid of an L.B. condulet into a Trumbull safety, type H, entrance switch. From the switch the a.c. leads are carried in conduit to a General Electric manually operated compensator having a push button stop. From the compensator the a.c. leads are carried to the motor under the floor in 2-in. conduit. This conduit is run directly into the motor terminal head so that no wires are exposed.

A pair of 500,000 c.m. direct current leads and a No. 8 field wire are run under the floor in 3½-in. rigid metal conduit from the generator to the back of the switchboard, type B condulets being used on each end of this run. The switchboard is made up of a generator panel, two charging line panels and a bracket meter panel. The generator panel is equipped with a double-pole carbon-break circuit breaker with instantaneous overload release, a voltmeter showing generator voltage, and ammeter showing total generator output, and a field rheostat for controlling the generator voltage. The charging panels are each made up of four Westinghouse charging panels and each of these small panels is equipped with a Westinghouse, type C, magnetic circuit breaker, a Ward-Leonard 0.24 ohm, 105-amp. resistance, and a special double pole knife, switch having extra contacts. The bracket panel is fitted with a voltmeter and an ammeter and two pilot lamps.

When one of the charging switches is pulled half way out, the blade of the switch engages with the extra contact and the ammeter on the bracket panel is put in series with that particular circuit and shows the amount of current being delivered to the battery. The same operation connects the voltmeter on the bracket panel. The pilot lamps on the bracket panel are connected to the bus which serves all of the charging panels so that the lamps show when there is voltage on the bus either from the generator or from a battery in the yard.

The Overhead Line Showing One of the Charging Receptacles with Its Dummy Plug

Three of the eight charging panels serve outlets in the battery house, one is a spare, and the other four serve charging lines in the yard. Two of these lines are long and two are short, so four No. 2 wires are carried out of the building with a No. 0 return for the two short runs

and a No. 00 return for the two long runs. All of the six wires are carried out of the charging plant underground in 2½ conduit under seven tracks, a distance of about 150 ft., to an overhead line run parallel to the tracks on poles.

Each piece of pipe in the underground run was treated before being laid to protect it from rust and from the acid in the cinder ballast. A bucket of hot tar was held under the pipe and a dipper used to dip tar out of the bucket and pour it over the pipe, the excess tar running back into the bucket. After all of the pipe, except the ends had received a coating of tar, the coating was allowed to harden just enough to become sticky and the pipe was then wrapped with burlap. The burlap was applied in strips about 6 in. wide put on in the same manner that insulating tape is put on a wire.

A second coating of tar was applied after the burlap was put on. The conduit was then laid and the joints treated in the same fashion before the trench was covered up. Water pipes given the tar and burlap treatment and laid in cinders have been in service on the Illinois Central for ten years without giving any trouble. In the case of the charging line the wires were pulled into the conduit more than a week after it was laid, but the ends of the wires which were pulled through did not show any trace of moisture.

The outer end of the underground conduit run is carried up the fourth pole in the overhead charging line. There are twelve poles in the line and the line is straight, parallel with the tracks and about in the middle of the yard, the poles are 25 ft. high and are spaced 100 ft. apart. The tar and burlap protection on the conduit is carried up about 3 ft. above ground and the conduit is carried to the top of the pole where it terminates in a type F condulet having a 6-hole cover. The wire used on the pole line is No. 2 triple braid weatherproof wire and runs are carried in both directions from the feeder pole. There is a charging outlet on each pole and there are three of these outlets connected in series in each of the four charging lines. On each pole top one of the lines is divided by strain type insulators and connections from the wires on opposite sides of the strain insulators are carried down the pole through a type F condulet and 1½-in. conduit to an Oliver L.B. 77, 250-volt, 200-amp. receptacle on the side of the pole 6 ft. above the ground. Each of the receptacles is fitted with a dummy or short-circuited plug, which is removed when charging cable plug is inserted.

Fifty and one hundred foot charging cables are used. They are made of two-conductor No. 4 Tirex cable with an Oliver plug on one end and an Anderson plug on the other which fits the Anderson type C charging receptacles used on the cars. When batteries are charged on cars which are on tracks not adjacent to the charging line, the charging cables are run from the nearest receptacle between the ties and under the rails to the car. Batteries are ordinarily charged two in series, but one battery can be charged separately whenever occasion arises which makes it necessary to charge in this manner.

The first all-electric car dumper to be installed on the Great Lakes is being built by the Wellman Seaver Morgan Company for the Toledo and Ohio Central Railroad at Toledo. This dumper will be used for transferring coal from railway cars to lake boats and will be capable of handling cars ranging in capacity up to 120 tons at the rate of 40 an hour. The electric equipment for operating the dumper will consist of a switchboard, two 3-unit motor generators, one 2-unit motor generator, four 450-horsepower motors for hoist and cradle turnover, and approximately 500 horsepower in direct-current mill type motors with magnetic control for the operation of auxiliaries, all the electrical equipment being of General Electric manufacture.

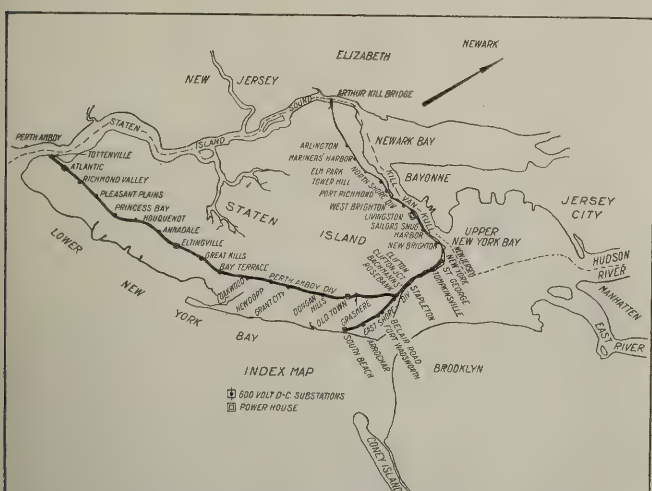
The Chicago Union Station Presents an Impressive Appearance from the River

Motor Car Train on South Beach Line

Electrification of Staten Island Lines

Operation Begins With 90 Motor Cars—Power is Supplied to Equipment By Automatic Substations

ELECTRIFICATION of the passenger service of the Staten Island Rapid Transit Railway Company was formally completed on July 1. The railway company is a subsidiary of the Baltimore & Ohio, and operates lines extending from St. George to Tottenville



Map of Staten Island, Showing Electrified Sections of Staten Island Rapid Transit

along the south shore of Staten Island in Borough of Richmond, New York City, with a short branch from Clifton Junction to the residential and summer resort section at South Beach. The line to Tottenville, known as the Perth Amboy division, which is 14 miles in length, serves principally residential sections beyond Clifton Junction. Between St. George Terminal and Clifton Junction the principal business section of St. George is served.

Information in this article concerning power supply was furnished by C. A. Butcher, general engineer, Westinghouse Electric & Manufacturing Co.

Ferry service is operated across the river between Tottenville and Perth Amboy, New Jersey. The East Shore line operating between St. George and South Beach, a distance of approximately four miles, serves in addition to its normal residential traffic a heavy summer season resort traffic. The New York Municipal Ferry operates between the Battery in lower Manhattan and St. George, and also between St. George and 39th street, Brooklyn. A line on the north side of the island known as the North Shore division handles traffic that is mostly industrial. Service on these lines has been operated by means of light steam trains made up of from two to six coaches.

To carry out part of the plan to electrify all railway service in the city of New York the East Shore and Perth Amboy divisions have been electrified for operation on 600 volts direct current. The arrangement provides for an over-running third-rail system, such as is used in the subway and on the elevated systems. Trains are of the multiple-unit type similar to those in subway service, and consist of from one to five cars. These trains are handled entirely by enginemen who formerly operated steam locomotives.

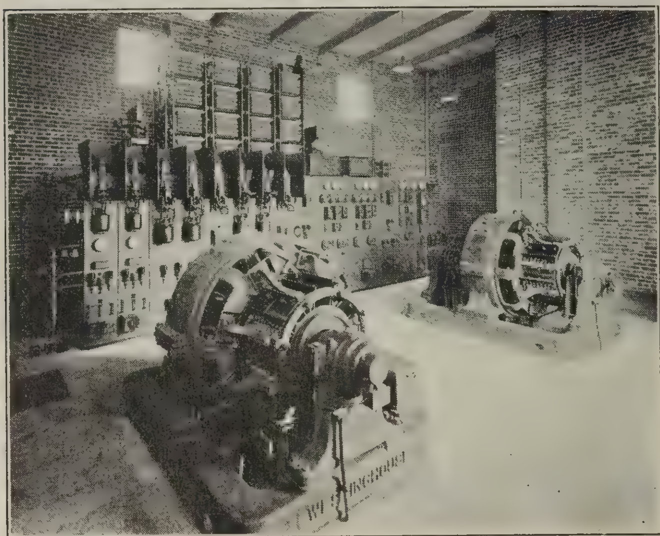
Rolling Stock

There are 90 motor cars in all of a design similar to those used in subway service. The cars were built by the Standard Steel Car Co. at Hammond, Ill., and are equipped with General Electric motors and control. They have a seating capacity of 71 and a total capacity of 186. Power is taken from a 600-volt top contact third rail and is controlled by a G-E electro-pneumatic type controller. The main controller is actuated from the motorman's position by a simple master controller, which handles circuits for the 200 hp. 600-volt motors.

The main controller consists of ten contactors for controlling the acceleration of the car operated by cams

located on a shaft driven by an air engine. The contactors together with the two line breakers open and close the circuits to the motors. Mounted in the same frame with the contactors and line breakers is a reverser which controls the direction of movement of the train.

The master controller operates from a 32-volt battery

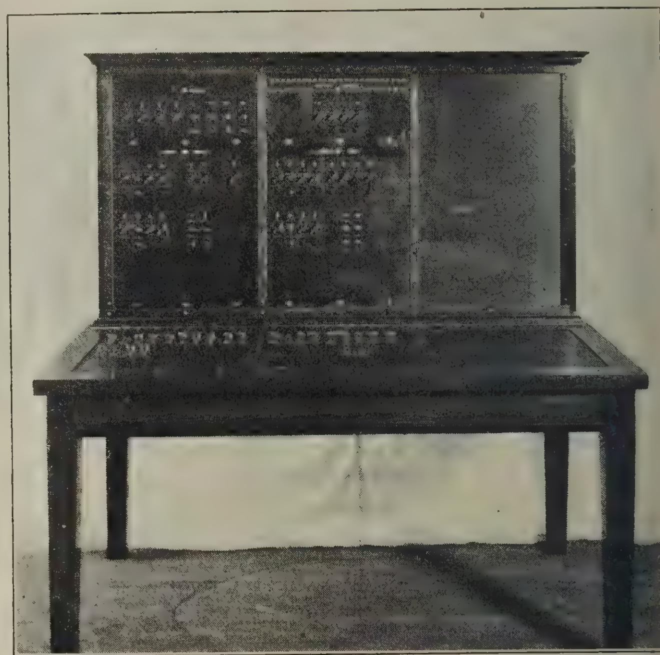


Interior of South Beach Substation

circuit arranged to actuate the several motor controllers through a multi-conductor train cable. The storage battery is the Edison B-1 H type and is normally charged by being connected in the negative side of the compressor circuit. Relays are provided for the control of battery charging and if the battery drops below 28 volts an additional charge is automatically made from the third rail through a resistance.

Each car carries four contact shoes which are connected to a train line bus connecting all of the shoes on the train. Power is, therefore, available when anyone of the third rail shoes is in contact with the rail.

Another feature is a bus line switch located at the end of each car by means of which the bus line can be disconnected from the coupling while making up the train. This is easily accessible to the trainmen when coupling



Traffic Operator's Central Desk

cars and precludes the possibility of the brakeman coming in contact with any live part.

The master controller includes two drums, one for reverse and the other for forward operation. The reverse drum has three positions—off, forward and reverse. The main cylinder has four positions including off, switching, series and parallel positions. In the switching position all motors and resistance are in series for switching movements. When the master controller handle is moved to either the series or parallel position, the train begins to

South Beach, Staten Island, Showing New Signals, Automatic Substation and Transmission Line

accelerate automatically and continues to increase its speed up to the full series or parallel connection of the motors.

Master controllers are equipped with the usual dead-man's release and also are so connected that an emergency application of the brakes is made when the control handle is released unless the reverse handle is locked in the neutral position.

One of the novel features provided on this equipment is an arrangement for dynamic braking, which can be used in case the power is cut off from the third rail. This connection is obtained by the motorman by operating the

Type of Steam Equipment Replaced by Electric

reverse and main control handles. Electric braking is obtained by changing the connections of the motor so that they act against each other as generators through the main motor resistors, the momentum of the car driving the generators. The current generated in this manner is dissipated in the resistors.

To provide for emergency operation with one motor in case of motor trouble a cutout switch is used which enables the operator to handle the car at reduced speed with one motor.

The gear ratio is 62/21 and provides a speed on the series connections of approximately 20 miles an hour, and on the full parallel of approximately 50 miles an hour. The maximum speed is obtained with reduced field connections.

All doors are operated by electro-pneumatic door engines, controlled by push-buttons located at the center and ends of the cars. The control circuits for these devices are connected to the 32-volt battery. To prevent the doors being opened while the car is in motion, a safety relay is provided which prevents the door engines from acting until the car comes to a stop. Provision is made for the independent operation of the door of the motorman's cab.

The cars are heated electrically by power from the 600-volt bus by means of coil type heaters located under both longitudinal and cross seats. The panel in the motorman's cab controls the heaters providing for the use of power on either all or part of these heaters. The temperature of the car is further regulated by a thermostat which automatically opens and closes the heater circuit.

Lighting is provided by four 600-volt circuits of five lights each controlled from a master switch on the main switch panel. The headlight is also controlled from this panel including four marker lights, two in the upper deck and two just above the floor line of the car; color changing devices are provided by which green, yellow or red display may be obtained for each of the two upper marker lights. A tell-tale signal in the motorman's cab gives indication when all of the doors of the train are closed. Six small emergency lights are also provided which light automatically when the third rail is cut off from the train.

Contact System

Contact shoes on the cars collect current from the third rail. The rail is a 150-lb. B.M.T. section made of copper bearing steel by the Bethlehem Steel Company. Each section is 39 ft. long and is mounted on Ohio Brass porcelain insulators. Shields and splice plates for the wooden rail guards were supplied by the Shield Electric Company.

On the greater part of the line the third rail joints are bonded by four 400,000 c.m. flexible copper bonds gas-welded to the rail ends. On one part of the South Beach line there are two 1,000-ft. lengths of third rail in which the joints have been welded by the Thermit process. The rail is sectionalized at certain points by Albert & J. M. Anderson sectionalizing switches enclosed in wooden boxes placed between the two tracks.

The running rails are 100-lb. rails. The joints are bonded by two 250,000 c.m. flexible copper bonds on each rail, gas-welded to the head of the rail. Manganese rails are used in the St. George terminal yard.

Power Supply

Electric energy for the system is supplied from five substations with an aggregate capacity of 10,000 kilowatts located respectively at St. George, South Beach, Old Town, Eltingville and Atlantic. Each of these substa-

The St. George Semi-Automatic Substation

tions, with the exception of the one at St. George, is automatically operated, while the St. George substation is equipped for semi-automatic operation.

A complete system of supervisory control, centralized in the traffic operator's office at St. George, places the control of the entire power system in the hands of the traffic operator, located at St. George, who will be continuously and automatically advised of the status of the power system.

Primary power at 33,000 volts, 3-phase, 60 cycles, is purchased and supplied over two circuits to each sub-

station from the new Livingston power plant of the Staten Island Edison Corporation. In order to meet a normal increase in demand for electric power, and to provide sufficient generating capacity for the operation of the railway system, the power company has remodeled and greatly enlarged the generating station at Livingston. The new equipment provides a complete new boiler plant from stokers to stack and a new 18,750 kv-a., 13,800-volt, 3-phase, 60-cycle, turbine generator with auxiliaries operating from a 2,300-volt 3-phase bus. Existing generating equipment generates for the most part at 660 volts with some smaller part at 2,300 volts.

New Signal System

The old train signalling system which was unsuited for operation on the electrified system has been replaced by a complete automatic block signalling system which receives energy for its operation from 2,300-volt, single-phase, 60-cycle lines. Located at four substations are transformer banks stepping down the 33,000-volt supply to 2,300 volts. Arrangements have been made so that each of a number of sections of the signalling system may be supplied normally from but one source. However in the event of failure of the normal source of supply, such section may readily be transferred to another circuit, thus preventing failure of the signals involved. The supervisory control system also places the control of the power supply to the block signal system in the hands of the traffic operator at St. George.

The St. George Substation

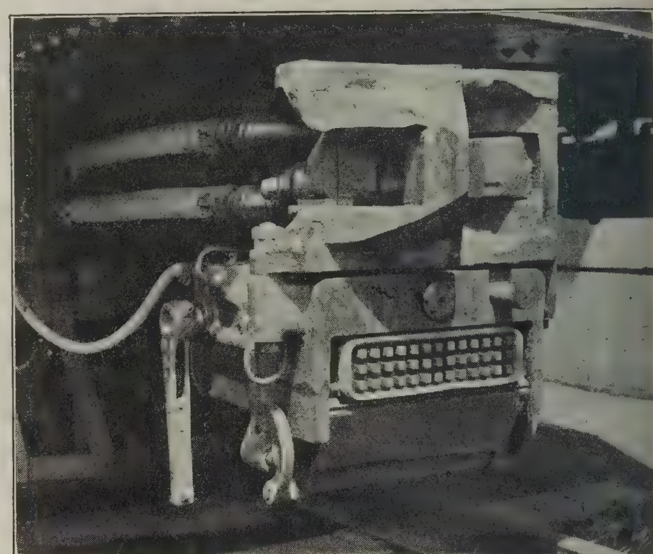
The St. George substation building is located in the terminal yards at St. George. As it is in a position which brings the roof of the building almost on the streel level, semi-outdoor construction for accommodation of the 33,000-volt switching equipment was resorted to in order to prevent exposure of the high-voltage equipment to the public thoroughfare.

Interior of One of the Cars

The portion of the power company's substation equipment which is indoors includes iron-clad, truck-type switching for a 2,300-volt, 3-phase double bus system for local distribution of light and power. Located in this station is also the supervisory control equipment for the operation of the 33,000-volt switching equipment at the Clifton Junction station.

The portion of the building occupied by the railway company provides space for four synchronous converters together with necessary transformers and switching equipment. Three 1,000-kw., 600-volt, shunt-wound, 60-cycle converters with auxiliary equipment comprise the present installation. However the space available will accommodate converters of at least double that rating.

With the exception of the manual starting equipment much of the switching equipment is automatic in its operation and a duplicate of that installed in the automatic substations at South Beach, Old Town, Eltingville and Atlantic, as later described.



One of the Automatic Car Couplers

Built into one corner of the machine room on the front side of the building is a two-story structure, the second floor of which is occupied by the chief traffic operator. The first story is divided into two separate parts, one serving as a battery room. The other is occupied by the traffic operator and in it are installed the telephone and supervisory control equipments which respectively put the operation of all trains and substation equipment under his supervision.

The Automatic Substations

Except for slightly different arrangements, the railway substation installations at South Beach, Old Town, Eltingville and Atlantic are the same. The Atlantic substation is at present equipped with only one converter unit, but provision has been made for a second, so that when it is installed the station will be practically a duplicate of the three other automatic stations.

The installation at each of the automatic substations comprises an outdoor structure, which accommodates two power transformers, signal transformer and switching equipment, the high tension switching equipment lightning arresters and outdoor metering equipment; also a brick building housing two 1,000-kw., 60-cycle, shunt-wound synchronous converters together with the automatic switching equipment.

Scheme of Control

The automatic stations are unattended except for periodic inspection. When the third rail voltage drops

to or below some predetermined minimum the station automatically comes into service by means of a contact-making voltage relay which is connected across the circuits to the third rail and the running rails.

To protect the machines from damage due to short circuits between the third rail and the running rail, a 3,000-ampere, full-automatic, electrically operated, high-speed circuit-breaker is connected to the machine circuit between the machine and the direct current feeder bus.

Section of Third Rail Showing Insulator, Thermit Welded Joint and Protection Board

Should an abrupt rise of current in excess of the momentary rating of the machine occur, this breaker, which operates to limit the current in from four to seven and one-half thousandths of a second, opens to insert into the circuit a resistor which limits to a safe value the amount of current supplied to the fault. As soon as the feeder breaker opens, the current is reduced to normal and the high speed circuit breaker and the resistor shunting breaker close to again restore full voltage to all feeder sections except the one on which the trouble occurs.

Each third rail feeder circuit is so arranged that, as soon as the short circuit is removed, the voltage relay transmits an impulse to the closing relays which operate to reclose the feeder breaker and re-establish the power circuit to that section.

In the substations containing two converters, the acceleration and normal operation of trains during non-rush hours will require the operation of only one unit. When the load becomes heavy, however, due to the use of more or longer trains in rush hours, the second converting unit automatically starts up in parallel with the first in exactly the same sequence of operation as that set into operation by the voltage relay in starting the first machine.

When the load demand on the substation falls to such a value that one machine can supply it and remains at or below this value for a predetermined length of time the machine which was the second to be placed in operation will be the first to be shut down. Further decrease in demand, making unnecessary the operation of the first unit, will result in it being taken out of service until further decrease in third rail voltage demands its operation.

The synchronous converters used in these stations are capable of delivering 50 per cent overload for two hours after reaching a constant temperature at full load, and are also capable of operating at 300 per cent of rating momentarily.

Protective Devices

In addition to the features of high-speed circuit-breaker protection, protection from abnormal overloads and the operation of feeder circuits, to clear faulty third rail feeder sections, there are numerous other "watch dogs" which protect the substation equipment. For instance, if the load shifting resistor, due to continued service, heat excessively, a thermostat operates to disconnect the machine from the load entirely until the resistor has cooled to a safe operating temperature. The machine is then automatically restored to service.

Also excessive temperatures of machines or transformer windings are prevented by thermal overload relays, which, in case of temperatures above a safe limit take the machines out of service long enough to reduce the temperature to safe values and then automatically restore them to service.

If a machine bearing heats excessively temperature relays on the bearings remove and hold the machines from service until restored manually.

A phase balance current relay shuts the machine down in the event of unbalanced phase conditions which would prove detrimental to the operation of the equipment. If the fault is within the substation the equipment is locked out of service until the conditions responsible for the unbalance have been corrected. If the unbalanced condition is the result of a fault outside of substation the equipment

Running Rail and Third Rail Joints Showing Gas Welded Bonds

is merely taken out of service until the condition is corrected, when service is automatically restored.

Voltage conditions, such as excessively low voltage, unbalanced voltage or reversed phase, are guarded against by relays which hold the equipment out of service under such conditions. These and other devices, such as overload relays, overspeed devices and reverse current relays, which are part of every manually operated substation equipment, provide still further protection.

Supervisory System

Experience in the operation of hundreds of automatically controlled substations has demonstrated their superiority of performance over manually operated equipment. However, automatic equipment set to perform a definite cycle of operations under given conditions cannot exercise judgment as to when it may be desirable to alter its performance. For example, due to an accident to a train which would make it necessary to discharge passengers at some point other than at a station platform, it would be desirable to de-energize the third rail as a matter of safety.

To give these "human" powers of communication to the automatic substations and to provide a means by which a person intelligently informed may exercise his best judgment as to the best operation of the apparatus a supervisory control system has been installed. From a certain point located in the traffic operator's office at St. George substation four wires constituting two pairs of a telephone cable radiate to each of the four automatic substations. On the traffic operator's control desk are located a control key and indicating lamps for each device in each station for which supervisory control has been provided. These keys and lamps are of the size and similar to such devices used on telephone switchboards. Small multi-contact control relays mounted near the desk in a steel cabinet and connected with similar installation at each substation causes the devices in the substations to function in response to the operations at the desk, initiated by the dispatcher.

In the operation of a signal to the dispatcher to indicate the automatic operation of a device at the substation the dispatcher in addition to receiving an audible signal notes the change in lamp indication that shows which device on the system operated. If the function were that of closing a circuit-breaker, the red lamp associated with that particular breaker would be lighted. Opening of the breaker would be shown by the lighting of the green lamp. Since the positions of the keys on the control desk indicate the previous status of the system, the change is immediately apparent even though the dispatcher were unaware of a change in color of the lamp indication.

Normally all equipment in the supervisory system is at rest. It functions only in response to operations initiated by the traffic operator or the automatic operations of the substation equipment. Should the supervisory system, for any reason fail to function, the stations remain under full automatic control. By means of this system the traffic operator may open or close any of the main power circuits and is able to start or stop any of the machines in the automatic stations.

The railway substation equipment and the switching equipment installed in the generating station and substations of the power company were supplied by the Westinghouse Electric & Manufacturing Company. Engineering and installation of the power company's equipment was by the J. G. White Enginering & Management Corporation. Engineering on the railway substation was under the direction of J. H. Davis, chief engineer of electric traction, and J. S. Hagin, special engineer, both with the Baltimore & Ohio Railroad Co. Installation of the railway substation equipment was made by the New York Service Department of the Westinghouse Electric & Manufacturing Company under the direction of H. D. Macy. R. B. White, general manager of the New York Terminal Lines of the Baltimore & Ohio Railroad, is in charge of operation of the Staten Island Rapid Transit Railway System.

Brush Composition and Brush Finishing

Previous articles of this series dealt with the first two of the three main divisions that can be made in a study of carbon brushes. The three divisions are: 1, Electrical characteristics; 2, Mechanical characteristics; and 3, Brush compositions. This article will deal with the composition of brushes and brush finishing.

Raw Materials

Pure carbon is found in nature in but two forms, graphite and diamond. The latter is, of course, of no importance in the carbon industry but carbon itself occurs profusely in combination with other materials and forms the basis of all our coals, oils and gases. Carbon as found in nature, can further be subdivided into two classes, the crystalline and the non-crystalline forms. Diamond and graphite are crystalline while amorphous or non-crystalline forms include animal charcoal, wood charcoal, lampblack, coke, etc. Artificial or electro graphite which can be made by a variety of processes, is now produced in quantity for commercial uses by the transformation of the amorphous form by the heat of a powerful electrical current.

Process of Manufacture

The brushes obtained from the materials referred to above vary in an amazing degree in their properties as a finished product. Therefore, after having passed through the purifying process the proper kind or kinds of raw carbon must be selected for any particular type of brush. This is properly mixed with some binding material and molded under heavy pressure into blocks. These blocks are baked for several weeks under high temperature. After this comes the testing and inspection and the blocks then go into stock. The blocks are now ready for the various finishing processes.

Brush Composition Characteristics

Both the electrical and mechanical characteristics of brushes vary with the composition. Brushes may be classified according to their composition as follows:

1. Amorphous carbon brushes.
2. Carbon and graphite brushes
   - (a) Mixture of carbon and artificial graphite.
   - (b) Mixture of carbon and natural graphite.
3. Electro graphite brushes.
4. Pure graphite brushes.
5. Brushes impregnated with a lubricating material.
6. Metal graphite composition brushes.

Amorphous Carbon Brushes—The amorphous carbon brush is hard and has the lowest current carrying capacity of any of the various grades. It is used in a few cases where commutating conditions are very severe, demanding a tough brush, but its field of application is not large.

Carbon and Graphite Brushes—The addition of graphite makes the brush softer and increases the current carrying capacity, also decreasing the coefficient of friction and contact drop. A great variety of characteristics are

found in the various grades of brushes falling in this class so that its field of application is quite large.

Electro Graphite Brushes are somewhat harder than the second class of brushes but as a rule are non-abrasive or practically so. They have better lubricating properties and higher current carrying capacities than the first two classes of brushes, and as a class, better commutating characteristics.

Pure Graphite Brushes—Brushes of this composition are the softest brushes and have the highest carrying capacity of any of the different grades of brushes with the exception of the metal graphite. On account of the softness of these brushes as low a spring tension should be used as is consistent with satisfactory operation. Brushes of this composition have excellent lubricating qualities, adapting them to high commutator speeds, and it is in this field that they find their most extensive application.

Brushes Impregnated with a Lubricating Material—As is generally known, the pore space in carbon brushes is about 25 per cent by volume and in this type of brush the carbon is impregnated with some lubricant. The coefficient of friction and commutator characteristics of the brushes are both improved by this treatment.

Metal Graphite Composition Brushes—Brushes composed of a combination of metal and graphite have the highest carrying capacity that it is possible to obtain except in all-metal brushes. These brushes are used on plating generators and on very low voltage direct current machines and on collector rings where the carrying capacity is too high for carbon or graphite brushes.

Brush Finishing

The cost of a brush is influenced largely by the finishing operations to which it must be subjected. In order to appreciate fully the foregoing it is necessary to understand the various finishing operations. Most brushes, of course, are not molded into their final shape but are cut from rectangular blocks.

Before enumerating the various finishing operations it will be well to consider carefully the conditions under which a brush is applied. It must be remembered that the brush is a part of an accurate piece of machinery. In the manufacture of a motor or generator, for instance, the armature shaft is finished to the thousandth part of an inch, the air gap between the pole faces is adjusted to the thousandth part of an inch, and the other parts, commutator, brush holders, studs, etc., are machined to an equal degree of accuracy. Therefore, it is only proper that the brush be machined with reasonable limits to properly fit the holders.

Take as a fair example, a brush to which is attached a No. 6A shunt. This brush goes through eighteen different operations before it is ready for shipment. This does not include several minor processes which cannot be classified as operations, but which nevertheless require time and attention. Many of the operations are performed on machines which are very similar to the metal working machines which require skilled workmen for their efficient operation.

The brush as it comes from the baking is rough and must be surfaced. It then starts its journey through the various departments. First it is cut to size, that is, to proper length and width, then the corners are beveled and it passes through its first inspection. After the first inspection the brush is drilled and counter bored, and sent to the specialty department where all the special work is done such as grooving, beveling and recessing. The brush is then ready for its second inspection. After it is cleaned it is ready for the special treatment or copper coating. After copper coating it passes through its third inspection. In this particular case the next operation consists of attaching the shunt. This is accomplished by special machines, the shunt being attached by a spun rivet. The brush and shunt connection is then tinned, given its final inspection and turned over to the stock or shipping department.

A discourse on brush finishing would not be complete without mention of a few of the difficulties encountered in the various operations. While many of the operations are performed on machines which are very similar to the metal working machines, the tools are radically different. Special tools must be designed and made to fit a variety of operations. In some instances, a tool that gives excellent service on one grade of brush is totally unfit for another grade or even all of the other grades, necessitating a change of tools for each grade of brush. And further, these special tools must be sharpened in a special way to provide proper cutting edge. In addition to the above a large amount of very special equipment is required to accommodate the numerous cuts and bevels that occur on brushes.

The breakage of brushes in the process of finshing is not a small item and even when the operations are slowed down to reduce the possibility of breakage an appreciable percentage of stock is reduced to scrap in this way. Many finishing operations are naturally slow because of the character of the cut or the brush material.

The varying conditions of motor and generator operation together with the large number of different sizes and designs of machines and brush holders require many grades and sizes of brushes. The number of different grades and sizes and brushes handled in the course of a year by a finishing department runs into the thousands.

Edison Battery Shaker and Dipping Tank

A compact and businesslike shaker for cleaning Edison batteries, shown in the illustration, was developed and has been in use for several years on the Florida East Coast at St. Augustine, Fla. It has suffered considerably from wear, but it has given such satisfactory service that it will soon be replaced by a new machine patterned after the old one, but built of better materials.

The machine is designed to handle three batteries in a crate. It is 60 in. high, 75 in. long, 35 in. wide and is built of 2 in. lumber. The shaking tray or table is 2 ft. square, and the bottom of the table is fitted with pieces of angle iron spaced just far enough apart to hold the battery tray. The ways on which the table moves are each fitted with four window sash cord rollers. The sheave wheel of these rollers projects slightly above the surface of the ways so that the table rolls rather than slides. The under surface of the table is provided with flat iron strips where it rides on the rollers.

The machine is driven by an air motor. The air motor

is fitted with a short shaft about 16 in. long and drives the crankshaft through a pair of gears having a ratio of 2½ to 1. The crank has a 4 in. throw and the connecting rod is a Ford engine connecting rod. The wrist pin couples the connecting rod to a ½ in. by 2 in. flat iron strip which is in turn bolted to the shaking table. End thrust of the table is absorbed by four coil springs, two at each end, so mounted that the table strikes these springs just before it reaches the end of its travel. The springs ar 6 in. long, 2 in. in diameter and are made of 5/16 in. spring steel.

Water is used to clean the batteries and it is brought to the machines through a piece of ¾ in. pipe strapped to the top of the frame. The pipe is fitted with several tees and a cap. The tees are fitted with reducers and ⅛ in. nipples and rubber tubes are connected to three of the nipples. The other ends of the rubber tubes are slipped onto U-shaped pieces of copper tubing. One end of each tube is kept from falling out by spring slips made for the purpose. A wooden box or sink under the shaking table catches the washing water and from the box the water drains to the sewer.

When batteries are brought in for general overhauling, the dirt is first taken off the outside with a steam hose and after the solution has been poured out, the batteries are placed on the shaking table and the water tubes fastened into the filler openings. A slow stream of water is allowed to run into the batteries and the air motor is kept running until the water comes out of the batteries clean.

Fig. 1—Edison Battery Shaker Used by the Florida East Coast at St. Augustine, Fla.

The batteries are then drained and are ready for painting and refilling. It has been found that the shaker will clean four or five sets of batteries in the same time that a man can clean one set by hand.

After the batteries are cleaned inside and out and refilled, such repairs as may be necessary are made to the trays and they are taken to the dipping tank, Fig. 2. The first tray is lifted to the edge of the table shown at the right and is then picked up by the two long iron hooks and the block and tackle as shown. The tackle is made up of a double and a single block strung with ⅜ in. rope. The hooks are made of ⅜ in. round iron rod and measure 24 in. from the ring to the turn of the hook which grips the handle of the battery tray. The upper block of the tackle is suspended from a large pulley sheave. The sheave wheel rests on a piece of 1 in. pipe about 8 ft. long suspended horizontally from the ceiling. The pipe is 6 ft. above the table shown at the right and is parallel to the table.

The dipping tank back of the table, Fig. 2, is 28 in. long, 10 in. wide and 19 in. high. The table is 2½ ft.

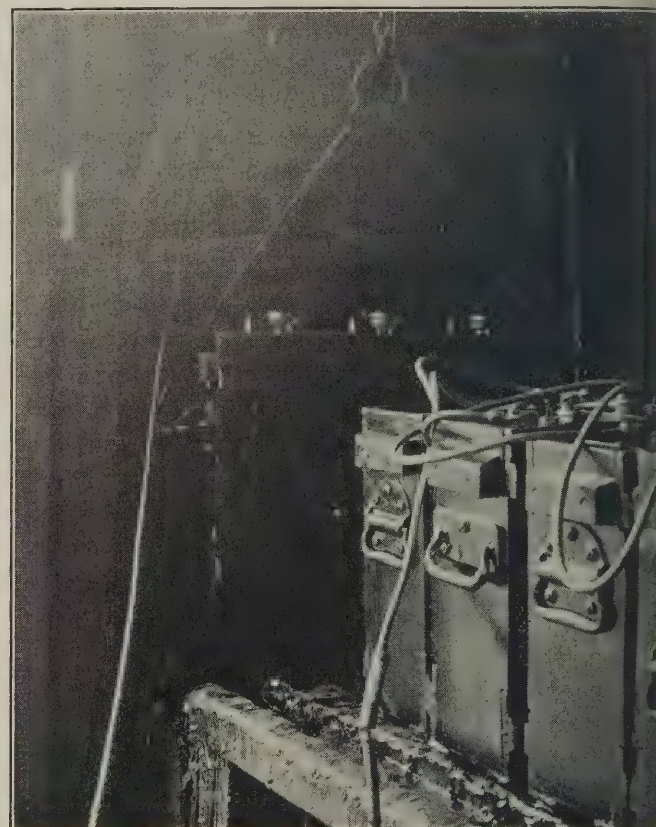


Fig. 2—Dipping Tank and Drying and Charging Table

wide and 6½ ft. long; large enough to accommodate the nine battery trays of a 25-cell battery. The surface of the tray is provided with longitudinal ribs or cleats which hold the trays up off the table and allow excess paint to run back into the tank. At the tank end the table is 23 in. high and at the opposite end it is 27 in. high.

The cleaned battery tray after being picked up by the tackle, as shown in Fig. 2, is lowered into the paint tank so that the paint comes up to within a fraction of an inch of the top. It is then lifted out, allowed to drain for a moment and is then moved to the right hand end of the table by rolling the sheave pulley which supports the tackle along the pipe suspended from the ceiling. The tray is then lowered to the table. Each tray is dipped in turn until all of the nine trays are painted and are standing in line on the table.

The next operation consists of painting the upper edges of the trays with a brush and of pouring Parowax over the tops of the batteries. While the paint is drying the battery is connected and put on charge and is then returned to service.

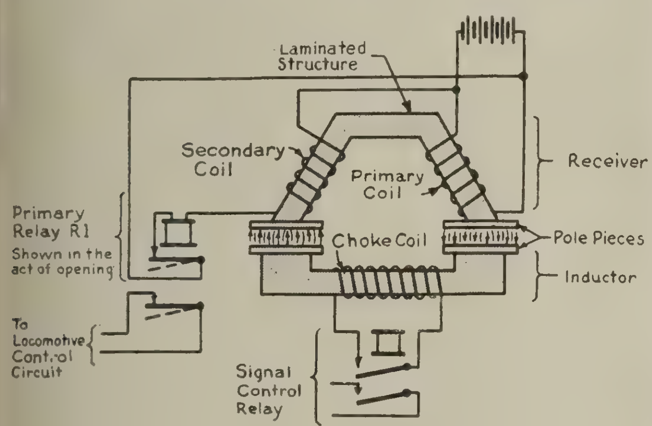
With the aid of this equipment, all of the work of cleaning, repairing and painting a battery can be done by one man.

Installation of Train Control on the Southern

Intermittent Inductive Auto-Manual System Now Under Construction on 639 Miles

By W. J. Eck
Superintendent of Signal and Electrical Dept. Southern Ry.

THE Interstate Commerce Commission in its order No. 13413, dated June 13, 1922, directed the installation of automatic train control upon one passenger locomotive division upon the Southern Railway and the Cincinnati, New Orleans & Texas Pacific. Both of these roads being component parts of the Southern Railway System. On January 14, 1924, a second order was issued extending the scope of the first order so



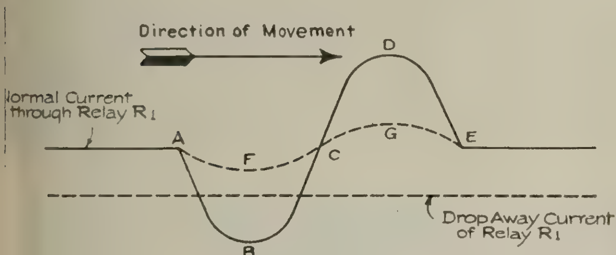


Fig. 1—Circuit Showing Principles of Electromagnetic Control Between Wayside Inductor and Locomotive Receiver
Fig. 2—Current Curve for Engine Relay R-1

that at present two divisions on each road, or a total of four divisions for the system, must be equipped.

Upon receipt of the order of June 13, 1922, steps were immediately taken to equip 10 locomotives and 35.5 miles of double track on the C. N. O. & T. P., between Ludlow, Ky., and Williamstown. This territory is a part of the division selected for the installation of train control under the Commission's orders.

The purpose of equipping this preliminary section was for the development of the type of train control selected, under actual service conditions, before undertaking the extensive installation required by the Commission, this preliminary installation being made upon behalf of both the Southern and the C. N. O. & T. P.

All of the field work, on an installation of the General Railway Signal Company's inductive tapered speed control, had been completed and considerable work finished upon the locomotive equipment when the Commission modified the functions required of an automatic train stop contained in the original order. This was issued on July 18, 1924, and consisted in the restoration of a clause which provided for the so-called "permissive feature."

The paragraph changed was as follows:

1. Automatic train stop.
   (a) No change.
   (b) (added).

Under control of the engineman, who may, if alert, forestall the application of the brakes by the automatic train-stop device and control his train in the usual manner in accordance with hand signals or under limits fixed by train order or prescribed by the operating rules of the company.

This change was of the utmost importance to the railroads installing train control, particularly to those operating with traffic of light or medium density. It permits the use of an automatic stop which can be installed at a much less cost than any system of speed control known and yet gives practically all the protection that can be expected from much more elaborate systems of automatic control.

The management of the Southern Railway System rec-

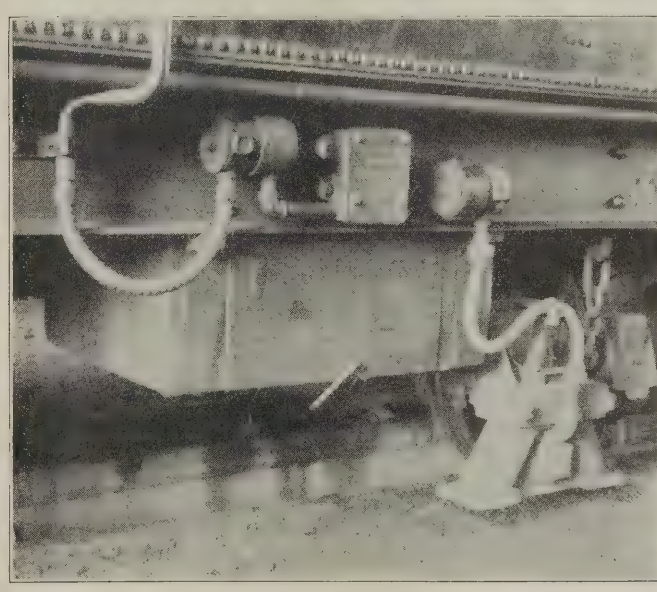


Fig. 3—Reset Contactor Mounted Upon Tender Frame. Receiver Hung on Truck Bracket

ognized at once the manifest advantages of such a system over that formerly permitted by the Commission. Work was stopped on the speed control device being installed and arrangements made with the General Railway Signal Company for a preliminary installation of their auto-manual type of automatic stop in the same territory.

Description of the Devices and System Being Installed

The system adopted by the Southern is the intermittent inductive auto-manual automatic stop. The object of this

system is to enforce the observance of the speed restricting indications of wayside signals by compelling the engineman to perform some manual act called "acknowledging" when passing either the caution or stop indications of wayside signals. The penalty for failure to acknowledge either of these signal indications is an automatic brake application from which the brakes cannot be released until the train has been brought to a stop.

The control device between the wayside and the locomotive is composed of two parts, a "receiver" and an "inductor." The receiver is carried by the locomotive and is securely fastened to the trucks of the locomotive tender and consists of an inverted U-shaped magnet with laminated cores, large pole pieces and two coils. The inductor consists of a U-shaped magnet with laminated cores and pole pieces the same shape, size and spacing as the pole pieces of the receiver. It is located on long ties and special tie plates with its pole faces 2½ in. above the top of the running rail and its center line parallel with and 20½ in. outside the gage line. The receiver is adjusted so that as the locomotive moves along the track the pole faces of the receiver pass about 2 in. above and

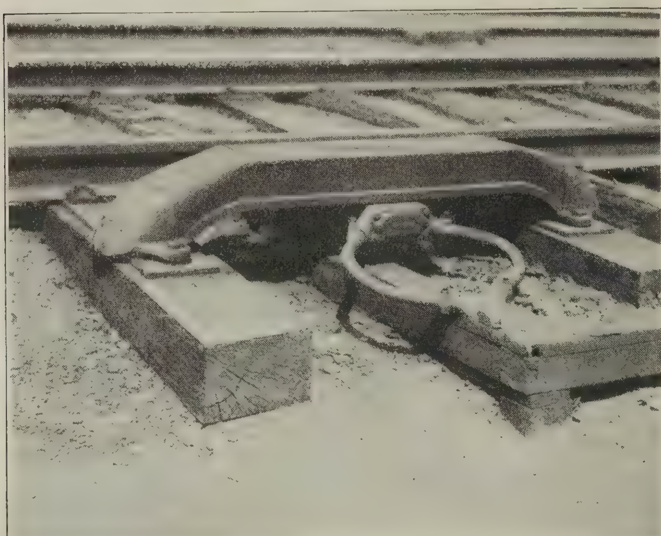


Fig. 4—Inductor in Place; Note Special Design of Terminal Box to Keep Wires Separate

directly over the inductor pole faces. Figure 5 shows the clearance diagram for receivers and inductors as they are mounted.

Theory and Action of the Electrical Connections

One of the two coils of the receiver is called the "primary" coil and, being constantly energized by current from the electric headlight generator, produces a strong magnetic field. The other coil, called the "secondary" coil, is connected to the same source of energy and in series with the coil and front contact of relay *R-1*, through which a current of about 13 milli-amperes flows normally. All of the inductors used in this installation are wound inductors, that is they are provided with a choke coil which is automatically controlled through the signal system in such a way that when a speed restricting impulse is to be given the coil is on open circuit and when no impulse is to be given the coil is closed on itself.

When the receiver, Fig. 3, carried by a locomotive, approaches an inductor on open circuit, a surge of magnetic flux builds up in the secondary coil and produces a negative current in the relay as shown by a curve *A-B-C*, of engine relay *R-1*. This negative current is sufficient to allow the relay to open, and once open, stays open until restored, due to its being a "stick" relay. Current curve *A-B-C-D-E* shows approximately how the normal current through the relay *R-1* would be varied as the

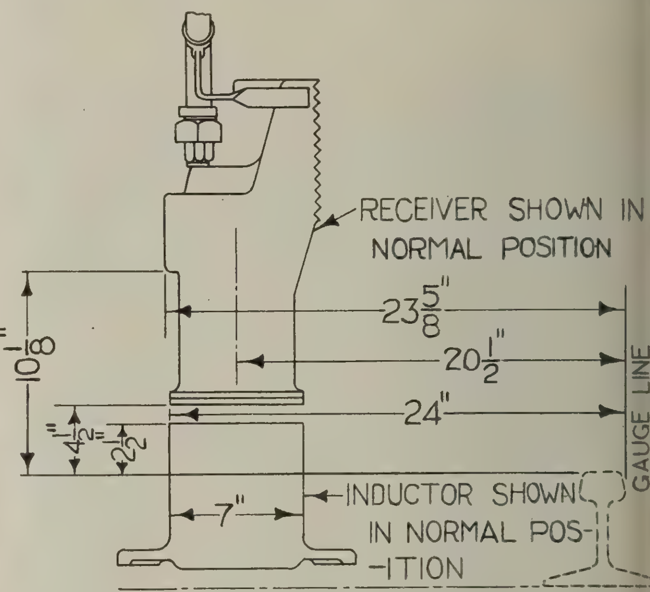


Fig. 5—Clearance Diagram for Mounting Receivers and Inductors

result of a receiver passing an inductor on open circuit if this relay were "non-stick," the amplitude of the cycle varying with the speed at which the receiver passes the inductor. It is to be noted that a valuable characteristic of a purely inductive device is, that the certainty and magnitude of the transmitted electrical impulse increases with speed.

Current curve *A-F-C-G-E* shows approximately how

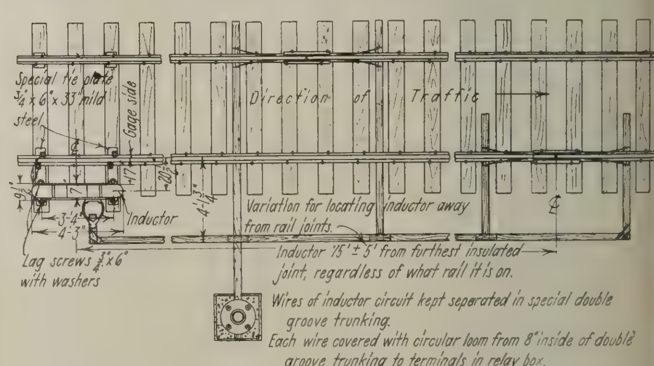


Fig. 6—Inductor Location with Reference to Insulated Rail Joints

the normal current through relay *R-1* would vary as the result of a receiver passing an inductor on closed circuit which would be the case under proceed signal conditions. The amplitude of the cycle *A-F-C-G-E*, as a result of the effect of the choke coil is never enough to cause relay *R-1* to open.

The receiver proper is protected by a non-magnetic casing adjustably mounted in such a way that no springs intervene between the receiver and the axle. Figure 3 shows the manner in which receivers are protected and the mounting on the tender truck. The terminals for

the receiver windings are made easily accesssible for testing and inspecting by removing a small cover plate on the side of the receiver housing and the wires leading from the receiver are connected to the locomotive wiring through a plug coupling which facilitates the making of repairs to the locomotive as well as the matter of replac-

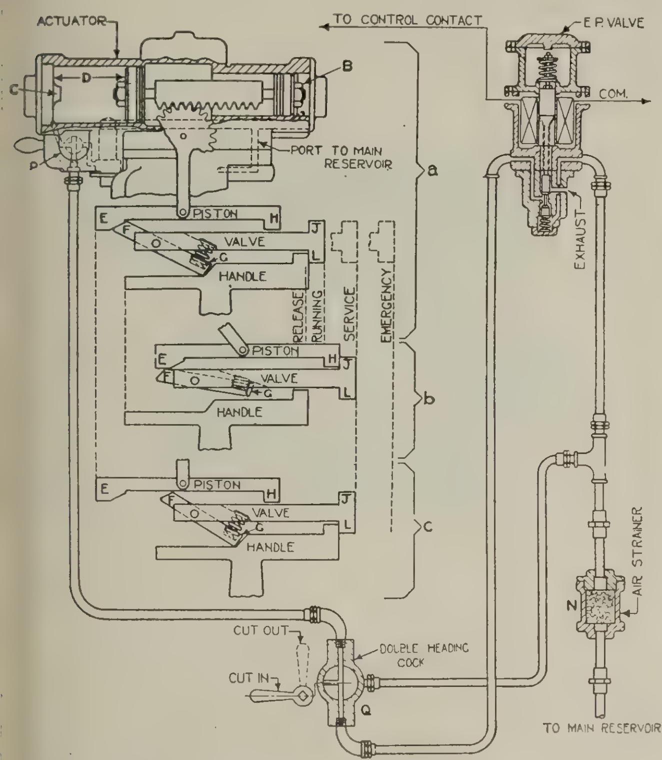


Fig. 7—Operating Diagram of Brake Application Apparatus

ing a receiver. This coupling has been especially designed for train control work and is rugged, makes perfect contact, cannot separate in service, is easily parted when desired for inspection or when repairs to the locomotive

Fig. 8—Electro-Pneumatic Valve Is Completely Enclosed

are necessary and it cannot be put together except in a proper manner.

The inductor, Fig. 4, is protected by a strong, ramp-shaped, non-magnetic housing securely fastened to special tie plates on long wood ties, in such manner as to maintain correct operative relation between the rail and the inductor. The two terminals for the inductor winding are located in a conduit fitting attached to the side of the inductor housing and the connecting wires lead into trunking through separate flexible armored conduits as shown. The trunking for these wires is provided with a double groove to prevent effectually any possibility of the wires coming in contact with one another.

Operation of the Brake Application Apparatus

The brake applying apparatus shown diagrammatically in Fig. 7 consists of an electro-pneumatic valve and a pneumatic device called a "brake valve actuator" for operating the engineman's brake valve to the service posi-

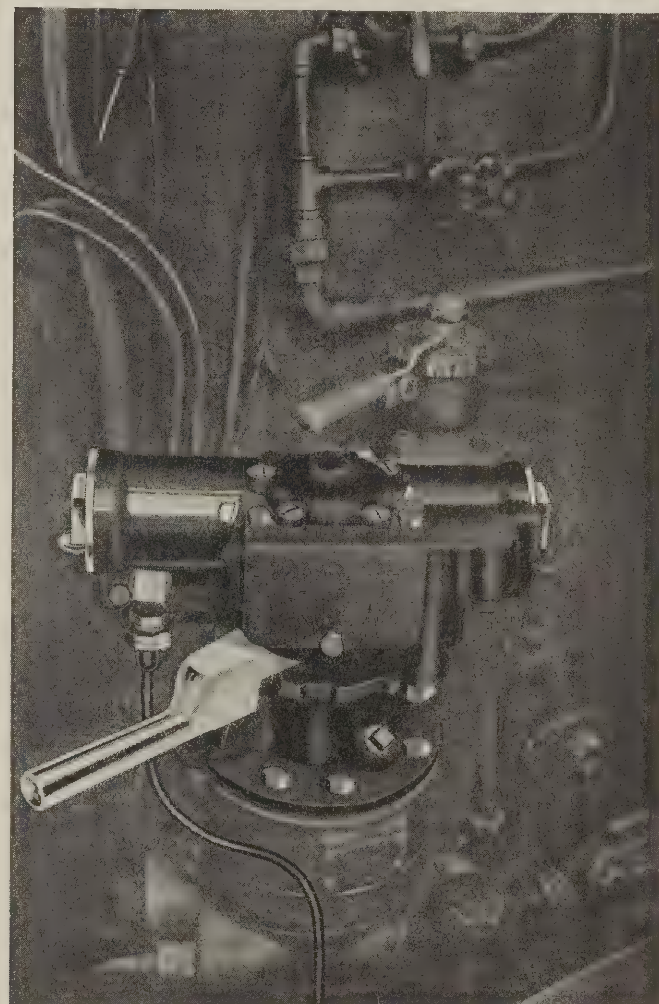


Fig. 9—Actuator Applied to Engineer's Brake Valve

tion. While the actuator can be used with or without a means for limiting the service application to a pre-determined brake pipe pressure reduction, the limiting feature is not used in this installation.

The actuator in place on the engineman's brake is shown in Fig. 9 and Fig. 8 shows the electro-pneumatic valve. The circuit to the electro-pneumatic valve is controlled primarily by the engine relay *R-1* previously described, and also in connection with certain other relay contacts which will be described later.

Referring to the diagram Fig. 7 the part marked "piston" is attached to and operated by the piston of the actuating cylinder. The part marked "valve" is con-

nected to the "rotary" of the brake valve. The part marked "handle" is connected to and moves with the brake valve handle.

Under all conditions, air direct from the main reservoir is supplied to the cylinder *B* which is the smaller of the two cylinders of the actuator. When the E. P. valve (electro-pneumatic) is energized, air is supplied from the same source through the air strainer *N*, the E. P. valve, the double heading cock *Q*, and the cut-out cock *P* to cylinder *D*, the larger of the two cylinders of the actuator. The piston is, therefore, shifted to the extreme left hand position as indicated in that part of the diagram shown within the bracket *a*. Under these conditions the actuator is entirely disconnected from the

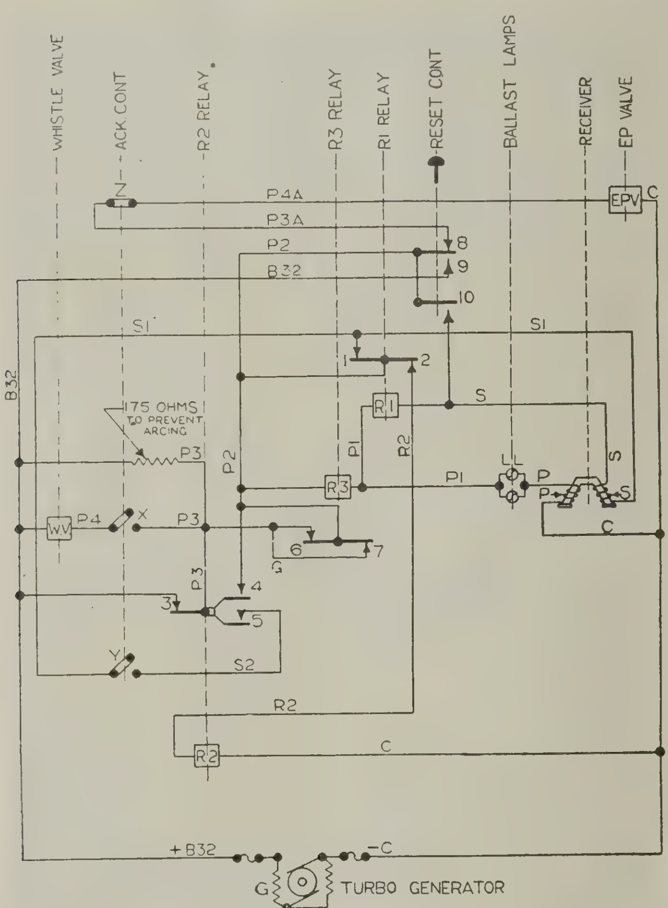


Fig. 10—Typical Locomotive Train Control Circuits

brake valve handle so that the engineman has the same control of the brake valve that he would have if the actuator were not installed.

When the E. P. valve is de-energized, air is exhausted from the cylinder *D* which allows the air in the cylinder *B* to move the actuator piston to the left until it comes against stop *C*. During the first part of this movement, the cam surface *E* on the piston, being moved to the right, comes in contact with the latch *F-G* which is attached to the valve, lifting the portion *G* out of engagement with the handle. During the rest of the movement, the lug *H* on the piston is in contact with the projection *J* on the valve so that the valve is moved to the right to the service position as indicated in that part of the diagram included within the bracket *b*. In this position, it will be noted that the handle is disconnected from the valve in such manner that the valve cannot be moved by the handle towards the left or release position. The valve can, however, be moved to the right or emergency position. The engineman can, therefore, make an emergency application at any time, but he cannot again move the brake valve until the E. P. valve is re-energized by a reset. This cannot be made until the train has been brought to a stop, as will be explained later.

In order to regain control of the brake valve after it

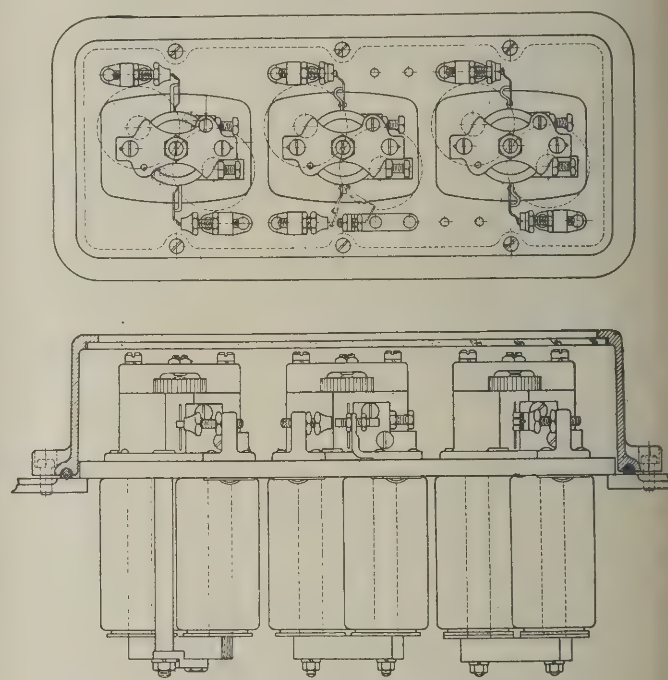


Fig. 11—Relay Construction and Grouping of R1, R2, R3

has been moved to the service position by the actuator as explained above, the E. P. valve must first be re-energized by the operation of a reset contactor. This allows air to again flow into cylinder *D* of the actuator which moves the piston back to its original position as shown in that part of the diagram included within the bracket *c*. The engineer then places the brake valve handle in the

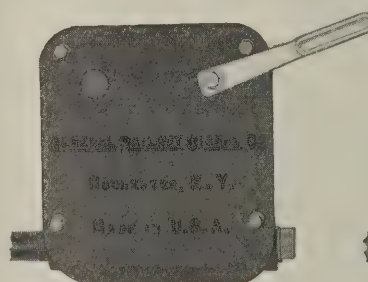


Fig. 12—Acknowledging Contactor With Cover in Position

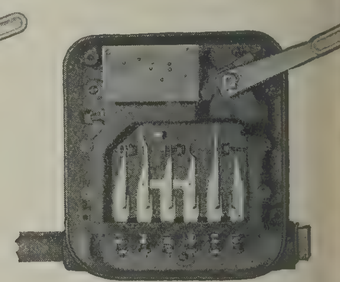


Fig. 13—Acknowledging Contactor Showing Contact Construction

service position which permits latch *F-G* of the valve to engage the handle after which he has regained control of the valve and may release. It is therefore noted that the service application made by the actuator is entirely automatic, whereas the release from this application is a manual operation.

The double heading cock *Q* in Fig. 7 consists of two separate cocks operated by the same handle which, in addition to its regular function, by-passes air around the

E. P. valve when operated to the cut-out position. The cut-out cock P is included as a part of the actuator and is normally sealed in the cut-in position. In case it becomes necessary to cut out train control for any reason, this cock may be operated by breaking a seal and turning the handle to the cut-out position. This simply admits air from the main reservoir into cylinder D and closes the air connection to the E. P. valve. A small indicator is provided on the actuator so that the engineman may know, at a glance, the position of the brake valve. This

Fig. 14—Reset Contactor with Cover Removed

indicator is shown in Fig. 9 on top of the actuator to the right of its center.

Explanation of Wayside Control Circuits

An inductor is placed in rear of every signal as shown in Fig. 6 and the wayside circuits controlling it are very simple. It is only necessary to arrange so that when the signal displays a restrictive indication, the coils of the inductor are open and when the signal is in the proceed position the coils of the inductor are closed.

Explanation of Locomotive Circuits

Typical circuits used on the locomotive are shown in Fig. 10 and the following is an explanation of the nomenclature and a brief description of the contacts and magnets employed:

S—Secondary coils of the receiver, see Fig. 1.
P—Primary coils of the receiver, see Fig. 1.
G—Turbo-generator, the one used on the locomotive for lighting purposes.
EPV—Electro-pneumatic valve controlling air to the brake applying actuator, see Fig. 8.
R1—Primary relay operated by the locomotive receiver, see Fig. 1.
R2—Secondary relay controlled by relay *R1*.
R3—Relay controlling the electro-pneumatic valve. (Fig. 11 shows the grouping and construction of relays *R1*, *R2* and *R3* and Fig. 15 shows the relay housing).
WV—Electro-pneumatic valve controlling air to an audible signal, see Fig. 8.
LL—Ballast lamps used for correcting the fluctuation of the voltage of the turbo-generator. Any increase in current through the ballast lamps heats the filament which reduces the current, or a decrease in current through the lamps cools the filament and increases the current, therefore, the ballast lamps serve to limit the current through the relays *R1*, *R2* and *R3* to the proper amount during a fluctuation in voltage of the turbo-generator.
Ack.—Acknowledging contactor, see Figs. 12 and 13.
Cont.—When the operating handle is moved from its normal position contacts X and Y are closed and a clock-work mechanism is started so that if the handle is held down for a longer period than 15 sec. contact Z will open.

The locomotive circuits used are for automatic train control protection for forward running only and Fig. 10 shows the connections and position of parts as they would be when the train is running subject to automatic control between impulse receiving points. Under these conditions the active circuits are as follows:

P—The primary coil of the receiver is energized by current flowing from the positive side of the generator through wire *B32*, contact *3* of relay *R2*, wire *P3*, contact *6* or *7* of relay *R3*, wire *P2*, the coils of relay *R3*, wire *P1*, the ballast lamps *L.L.*, wire P through the primary coil of the receiver and wire C to the negative side of the generator.

R3—The relay *R3* is energized by the circuit last described.

R1—The relay *R1* is energized by the drop in voltage across the coils of the relay *R3* due to current flowing in the circuit last described. The circuit is as follows: Starting from the left hand side of the coils of relay *R3*, wire *P2*, contact *1* of relay *R1*, wire *S1*, secondary coil of the receiver, wire S, coils of the relay *R1*, wire *P1* back to the right hand side of the coils of relay *R3*.

S—The secondary coil of the receiver is energized by the circuit described above for relay *R1*.

R2—The circuit which supplies current to the coils of relay *R2* is traced as follows: Starting from the positive side of the turbo-generator, through wire *B32*, contact *3* of relay *R2*, wire *P3*, contact *6* or *7* of relay *R3*, wire *P2*, contact *2* of relay *R1*, wire *R2*, the coils of relay *R2*, and wire C to the negative side of the generator.

EPV—The electro-pneumatic valve is receiving current through the following circuit: Starting from the positive side of the turbo-generator, wire *B32*, contact *3* of relay *R2*, wire *P3*,

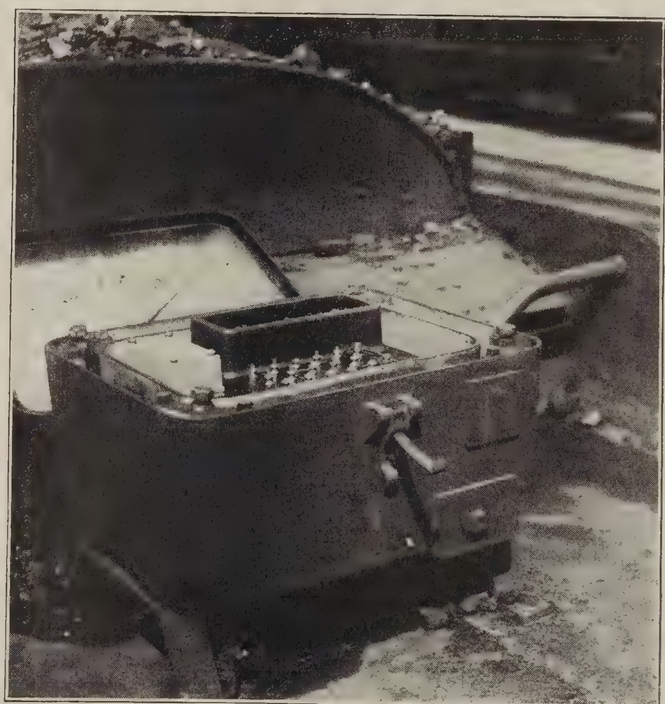


Fig. 15—Locomotive Relays and Ballast Lamps Are Mounted in an Inner Case Which Is Floated on Springs

contact *6* or *7* of relay *R3*, wire *P2*, contact *8* of reset contactor wire *P3A*, contact Z of the acknowledging contactor, wire *P4A*, the coils of the electro-pneumatic valve and wire C to the negative side of the generator.

Operation of Locomotive Circuits

When the receiver passes an inductor whose coils are closed through the contact points of the track relay and the circuit controller at a proceed signal, the current through the relay *R1* is not materially changed, but when the receiver passes over an inductor whose coils are open, the current through relay *R1* is decreased, so that its contacts are opened. The opening of contact 2 of relay *R1* deprives relay *R2* of current and the opening of contact *3* of relay *R2* deprives relay *R3* of current. The opening of contacts *6* and *7* of relay *R3* deprives the electro-pneumatic valve of current, and as previously

described, a full service brake application results. The E.P. valve cannot then be supplied with current until relay *R3* is again energized. Relays *R3*, *R1* and *R2* are re-energized by the operation of the reset contactor. When contact *9* of either of the reset contactors is closed, relay *R3* will receive current through the following circuit; from the positive side of the generator, through wire *B32*, contact *9* of the reset contactor wire *P2*, coils of relay *R3*, wire *P1*, ballast lamps *L.L.*, wire *P*, primary coil of receiver, wire *C* back to the negative side of the generator. This produces a drop in voltage across the coils of the relay *R3* so that the relay *R1* will be energized by the following circuit: Starting from the left hand side of coils of relay *R3*, wire *P2*, contact *10* of reset contactor, wire *S*, coils of relay *R1*, wire *P1* back to the right hand side of coils of relay *R3*. Having thus closed contact *2* of relay *R1*, relay *R2* will be energized so that contact *3* will be closed and the reset contactor can be returned to its normal position, thereby closing contact *8* which re-energizes the electro-pneumatic valve.

If, at the time the receiver passes over an inductor whose coils are open, contact *X* on the acknowledging contactor is closed, relay *R3* will not be opened, consequently the electro-pneumatic valve will not be deprived of current. The circuit which holds relay *R3* energized at this time is as follows: From the positive side of the generator, wire *B32*, the coils of the whistle valve *WV*, wire *P4*, contact *X* of the acknowledging contactor, wire *P3*, contact *6* or *7* of relay *R3*, wire *P2*, the coils of relay *R3*, wire *P1*, the ballast lamps *L.L.*, wire *P*, the primary coil of the receiver and wire *C* back to the negative side of the generator. With contact *X* of the acknowledging contactor closed and contact *3* of relay *R2* open, energy passes through the audible signal *WV*, causing a blast of the whistle. The blast, however, is of short duration because contact *3* of relay *R2* is opened only momentarily and when closed short-circuits the *WV*.

When the receiver passes over an inductor under these conditions, i. e., with contact *X* of the acknowledging contactor closed, the impulse received will cause relay *R1* to open, but since relay *R3* is energized, as explained, relay *R1* will immediately pick up. The momentary opening of relay *R1* opens relay *R2* which immediately picks up again. Immediately after the relay *R2* is opened, with the acknowledging contactor operated so that contact *Y* is closed, relay *R1* will be energized by the drop in voltage across the coils of relay *R3*, the circuit being as follows: Starting from the left hand side of relay *R3*, through wire *P2*, to contact *4* of relay *R2*, contact *5* of relay *R2*, wire *S2*, contact *Y* of the acknowledging contactor, wire *S1*, secondary coil of receiver, wire *S*, the coils of relay *R1*, wire *P1* back to the right hand side of the coils of relay *R3*. Energizing relay *R1* closes contact *2* of this relay which again energizes relay *R2* so that all of the circuits are restored to normal. It will be noted that if the contacts *X* and *Y* of the acknowledging contactor are closed for more than 15 sec. contact *Z* will open. This will deprive the E.P. valve of current and cause an automatic brake application. If the acknowledging contactor is not operated at the time an inductor is passed whose coils are open, circuits cannot be restored to normal until contacts *9* and *10* of the reset contactor are operated.

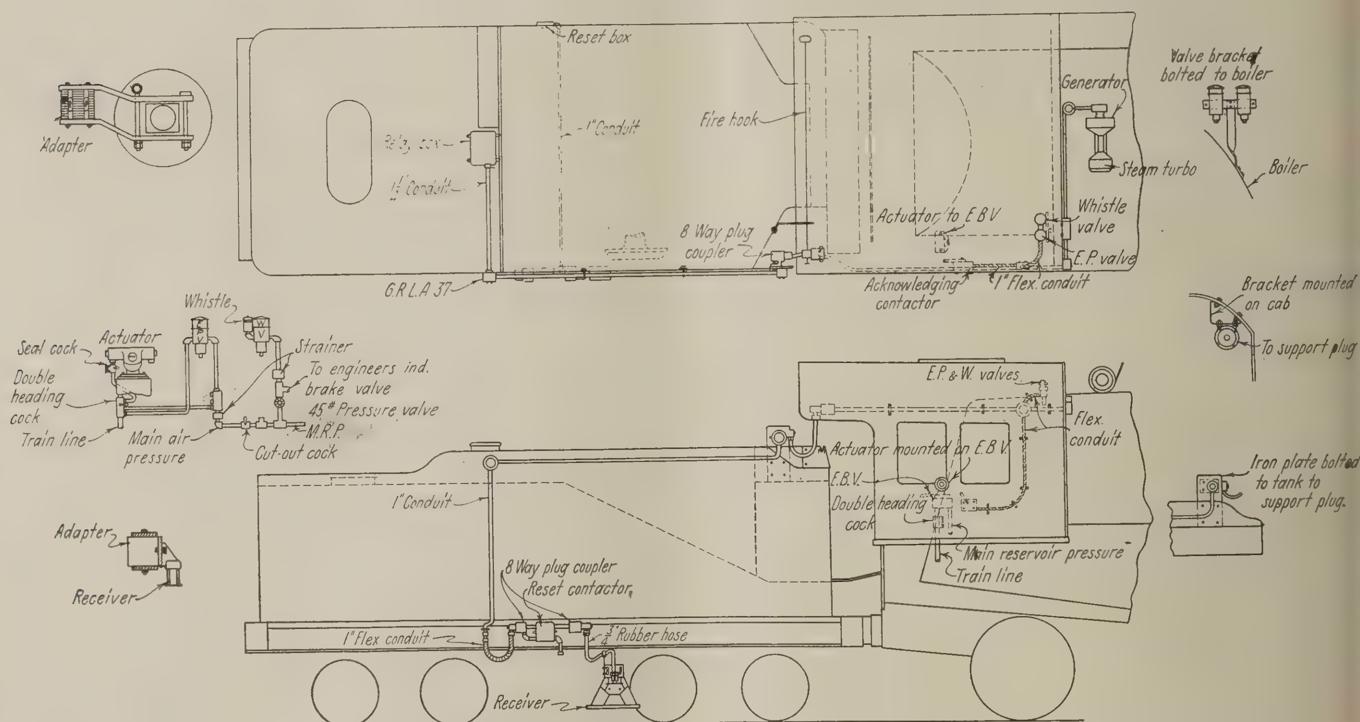


Fig. 16—Diagram Showing Assembly of Apparatus on the Locomotive and Tender with Details of Conduit Construction

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Nixie! Nixie! What Is a Nixie? It is a piece of mail so incorrectly or incompletely addressed, or so improperly prepared that it can not be delivered or returned without special treatment and it goes to ——.

The post office hospital for a postal operation. It differs from a dead letter in that a dead letter, parcel, or circular can neither be delivered nor returned, and goes to the post office morgue for burial. The handling of nixies and dead letters costs large sums of money.

Electric Locomotives in the C. M. & St. P. Yard at Deer Lodge, Montana

A. R. A. Reports on Electric Rolling Stock

Future Possibilities of Steam and Electric Locomotives—Shop Facilities Required for Electric Power

AT the annual meeting of the mechanical division of the American Railway Association held in Chicago recently, a most interesting report on the subject of electric rolling stock was presented by one of the committees.

As a preface to last year's report, the committee offered under the title of Outline for Future Work a general discussion of the economies of electrification as applied to existing steam operated railroads. Among the things exploited was the place held by the locomotive in railroad service with the possibility for more intensive operation and greater availability for service from motive power when proper study, planning and methods are applied. With that thought in mind it is well to consider means for obtaining maximum utilization.

A complete consideration must also include terminal electrification and the relative advantages of multiple unit train operation as compared with locomotive operation where such equipment is adoptable.

When the performance records of steam locomotives are reviewed over a considerable period of years with respect to availability for service, there seems to be indicated a retarding influence contemporary with the development of refinements and the increase in haulage capacity. These performance records further indicate that, whereas, the simple type of steam locomotive, as used some 25 years ago, was available for service approximately 75 per cent of the time, the modern steam locomotive seldom produces an average greater than 45 per cent. While obviously the addition of appurtenances and refinements, all of which improve the operating performance of the unit, will increase the amount of attention necessary to keep the locomotive in running order, yet, the decrease in service rendered cannot all be charged against such refinements. It would seem likely that a large percentage may be due to neglect in providing shop and terminal facilities in keeping with the requirements of the improved and larger power. Or perhaps the high percentage of unserviceable time may be due to a deficient understanding of the possibilities of the modern locomotive with its larger grate area, boiler dimension, general increase in proportions, and therefore greater margin of capacity as compared with designs of former years. Were these possibilities fully appreciated, then there would seem to be no logical reason for not providing and utilizing those facilities necessary for the prompt performance of shop and terminal work and thus obtain the maximum mileage performance between shoppings or terminal attention. Again precedent oftentimes places unnecessary restrictions on the realization of the wider range of service capacity of the modern locomotive, particularly where it is operated on the same division with power of a less recent design.

While it may appear inappropriate to dwell on deficiencies of the steam locomotive, nevertheless it is upon these deficiencies that great stress is placed by the proponents of electrification when the latter is under consideration. Such deficiencies should be taken into consideration by any road contemplating electrification and it seems only proper that cognizance be taken of them in this report. An outstanding advantage of the electric locomotive is the high percentage of serviceability as compared with the steam locomotive. Yet we cannot consistently compare them from this standpoint, unless provision is made for full utilization of the serviceability of which the modern steam locomotive is capable.

The steam locomotive of today is the product of many years of development with the view to simplicity and reliability with the result that the attainment of efficiency has been more or less sacrificed to that policy. Test locomotives have been built and successfully operated, under favorable conditions, whereby, through the utilization of stationary power plant practices, very high efficiencies have been obtained. However, it is quite doubtful that such types will become common, because the maintenance problem presented will greatly offset all other advantages. Generally speaking the average thermal efficiency obtained

from steam locomotives is little greater than one-half that obtained by the operation of electric locomotives on power generated at first-class stationary plants, properly operated, and the advancement in this respect is more pronounced in the latter than in the former, because of the more favorable conditions. Restrictions as to space is not a factor, skilled operators may be employed with the view to obtaining high thermal and mechanical performance, and refinements in equipment may be instituted since the problem of maintenace does not exist in the same degree as in the case of the locomotive. The possibilities for high thermal efficiencies are very much limited in the case of steam locomotives; the opportunities in this respect are in nowise restrained when applied to stationary power plants of considerable size. However, it should be said in passing this point that the possibilities for sustained service with steam locomotives have not yet been attained and it can be said further that were the inauguration of a group of modern engines within a certain section attended with the same engineering skill and given the same support as is done when electrification is set in operation the results obtaining might prove more competitive with the electric power.

The trend of development for stationary power plants in the future undoubtedly will be toward higher initial pressures and temperatures with the object of obtaining higher thermal efficiencies. Such a tendency will have its effect upon electrification projects through a lower unit cost of power. This gain in efficiency will offset a part of the transmission losses or for the same overall efficiency, will permit longer transmission lines and in turn, the concentration of larger quantities of power in the individual plant or plants and of course fewer such plants.

As before mentioned one of the pronounced advantages from electrification is the peculiar characteristic of this type of equipment which enables it to produce, under favorable surroundings, almost continuous service. Therefore, in laying plans for electrification, full recognition should be given this feature and traffic divisions, for one thing, should be so arranged as to permit long runs, or at least, continuity of runs that will make it possible to gain this advantage. Long mileage of electrified territory is, of course, favorable, but similar results can be accomplished by arranging for prompt return of power at the end of short runs.

The establishment of terminals and shop points has a great deal to do with making electrical operation economical. Repair facilities should be centralized in as few points as possible thus eliminating multiplicity of shop equipment and permitting the concentration of skilled workmen with a minimum capital outlay. Centralization of repairs within certain limits will react on the operation of the equipment to the extent of keeping it on the road, whereas, with a shop too convenient there is always a tendency to hold the locomotive for minor repairs that can readily be handled at the inspection points. Electric locomotives are not subject to many disorders customary with steam power and in consequence repairs are not necessary at intermediate points. The terminal should be merely a dispatching point where but little work is done other than the ordinary running terminal inspection and such minor adjustments as may be found necessary. There is small need for machine tool equipment at terminal points, but it is advisable to have a liberal stock of small parts in order to make replacements when needed. Trains should be dispatched promptly with a view of keeping the power on the road with as little lost time at the terminal as possible.

Consideration must be given to the cycle of wear of the various mechanical parts and electrical equipment within each unit of motive power with a view of repairing or renewing such items as become necessary, thus keeping the locomotive in service for the longest period practicable. In this connection it is recommended that extra parts be kept in stock to the extent of providing major units such as complete running gears, traction motors, track units, etc., thus reducing the total of complete units to a minimum. The same may be said of multiple unit cars as far as maintaining complete major repair units is concerned. The situation is different however, to the extent that ordinarily the equipment reaches a repair terminal on each trip so that the inspection point and repair point in general coincide.

In the routine care of electric locomotives, a difference from steam locomotives is distinctly noticeable. A well designed and operated electric locomotive or multiple unit car, if properly inspected and repaired at periodic intervals, may be run between these intervals without any attention, except such inspection as may be necessary to determine that the car or locomotive is in a safe operating condition. The intervals at which the inspection and repair periods must be set can only be determined by operating experience and a careful study of the individual car or locomotive design, having in mind that careful inspection, with minor adjustments, will frequently prevent the necessity for extensive work. It is, therefore, recommended that facilities for testing and inspection of electric locomotives and multiple unit cars at periodic intervals be developed to a high degree, in order to obtain perfection in the operation, and thus reduce detention and intermediate inspection to a minimum.

Fullest utilization cannot be obtained, unless there is full co-operation between mechanical and transportation departments. The successful adoption of electrification requires a full understanding of its peculiar characteristics by all concerned. Educational measures should be inaugurated for this purpose and means for adequate instruction should be instituted sufficiently in advance that those having direct charge of the equipment may be fully acquainted with electrical matters and thus be able to handle the equipment in the best possible manner.

Where practicable, there is a great advantage in using locomotives of the same type for all services within a given district or territory. It will lend greatly to the flexibility of service, reduce the multiplicity of repair parts and operations, and be a large factor in gaining sustained service.

Official Classification Rule Covering Movement of Gas and Electric Cars on Their Own Wheels

During the year a special assignment was given the committee to study and recommend changed wording of Official Classification Rule No. 47. The rule now reads as follows:

Gasoline or electric motor cars, on their own wheels, gear wheels disconnected: Actual weight less fifty (50) per cent with a minimum net weight charge of 36,000 lb. each.. 5
Actual weight subject to minimum weight of 30,000 lb.

After due consideration of the features involved, the following wording was unanimously adopted as the proper wording of the rule:

Gasoline or electric motor cars, on their own wheels:

1st, Self Propelled Cars Other Than Electric Driven: Transmission or driving rods disconnected or transmission positively locked in neutral.

2nd, Electric Motor Cars: Not to be shipped with motors mounted on trucks:

Actual weight less fifty (50) per cent with a minimum net weight charge of 36,000 lb. each 5

Actual weight subject to minimum weight of 36,000 lb.

It is further understood that:

(a) No reference herein applies to electric locomotives or self-propelled cars shipped over rails on their own wheels and under their own power.

(b) Unless transmission or driving rods are disconnected as provided above, an attendant must accompany all such shipments. In any event it is recommended that an attendant accompany all such shipments.

The Rule as rewritten meets with the approval of both the Westinghouse Electric & Manufacturing Company and the General Electric Company.

Inspection Rules

The sub-committee dealing with the subject of inspection rules of which J. V. B. Duer, electrical engineer, Pennsylvania, is chairman, is to continue without instructions until after the American Railway Association completes its conference with A. G. Pack, chief, Bureau of Locomotive Inspection, regarding new Interstate Commerce Commission inspection regulations covering locomotives other than steam operated.

Shop Facilities

As most of the heavier electrification projects have been attempted to handle some certain service condition or capacity, their detail operations have likewise been arranged best to meet the requirments. In consquence, the facilities have somewhat suggested themselves and have grown with the development of the undertaking. At the same time, with the introduction of electric equipment to work with or replace steam equipment, the essential additional features for the dispatching or running repair stations originally laid out for steam are not extensive. In a general way, facilities prepared for steam constitute practically or nearly everything needed for electric and more. At the general repair shops, the situation is somewhat modified and controlled by the type of equipment. In laying out new shops for either dispatching or general repair work, there may be conditions that might be rearranged to considerable advantage to improve the order of operations and efficiency.

With the change from steam to electric power, it is in some cases more economical to use multiple unit passenger equipment in place of electric passenger locomotives. When this is the case the passenger car terminal repair shop should receive careful consideration, and will probably require a more radical change than that compared with the steam locomotive dispatching terminal.

Multiple Unit Equipment

There are certain tools necessary for the maintenance of electric multiple unit equipment that must be added to those usually found in steam road passenger car shops. The design of equipment used on multiple unit cars is limited to such extent that the tools and other facilities are practically the same for both direct and alternating apparatus.

The major tools should comprise armature banding lathes, coil winding machines, commutator slotting machines, bake ovens, presses, test apparatus for magnet coils, field windings, separate lathe chucks for boring and fitting up motor and axle bearings and small tools for air compressor and control parts.

Inspection sheds should be provided to handle the required number of cars, and equipped with suitable well lighted inspection pits.

One of the most important facilities required in a well designed back shop is a large crane equipped with special hooks for lifting car bodies off their trucks and placing them on temporary or shop trucks. While most any type of car or locomotive shop would probably be suitable for multiple unit equipment, the output depends entirely on efficient handling of the truck repair work. Therefore, traveling cranes should be provided with sufficient capacity to handle complete trucks. Sufficient floor space should be provided between truck repair tracks for piling of repair material for assembly.

Locomotive Dispatching or Running Repair Stations

Treating on the facilities for the terminal handling of equipment in contra-distinction to repairs in connection with dispatching and running repairs, steam equipment essentially requires provision for coaling, cleaning fires and ash pans, supply water, hot and cold water for boiler washing and filling boilers, steam blower to accelerate firebuilding, suitable inspection pits, and a turntable or wye to handle engines for return trips. Practically none of these are necessary for the handling of electric power, except inspection pits, sand supply, water for rheostats, where used, and provision for fuel oil and water for passenger locomotives using a steam boiler for train heating purpose. Consequently, in changing facilities for the exclusive handling of electric power, they may be materially less than for steam. For the handling of steam equipment, as also applies to electric power, custom practically establishes one of the terminals reached in the course of the daily run or trip as the home or principal dispatching station. At this station, the major part of the running repairs is made, and in the interest of handling the work to advantage and economically, facilities are provided accordingly and in excess of those provided at the other terminals or outlying points. The facilities needed at outlying points for the handling of electric locomotives may be little more than inspection pits, and provision for sand and water supply, depending upon the type of equipment in use.

One idea of the comparison between the inspection and running repairs for steam and that needed for electric locomotives is that the former takes minutes for the inspection and hours to make repairs, while with the electric it takes hours to find the trouble and minutes to make repairs. These figures may be exaggerated, but serve to illustrate the reversal of the conditions.

The actual serviceable time of heavier steam power has been found to be in the neighborhood of 45 per cent as against 85 per cent for electric locomotives. This wide difference in serviceable time is no doubt due in part to the small amount of time required for the work on electric locomotives, in that complete units can be renewed in a comparatively short time. The longer time put on the steam locomotive is accounted for largely by the almost constant attention which must be given to the firebox, flues, stokers, guides, valve gear, reversing mechanism, piston and valve packing and periodic boiler washing and inspection. For electric locomotives inspection pits and means for supplying engines with sand and oil at outlying points are all that is necessary, except where passenger locomotives are handled means should be provided to supply oil and water.

For the handling of steam locomotives at the principal dispatching stations a turntable or wye is generally necessary to turn the power for the return run, and an engine house of the conventional circular form, with its turntable, well supplies convenience for the routine inspection and repair work. Similarly a turntable has been found valuable in connection with a rectangular engine house for the handling of electric locomotives composed of two or more units, and certain units of other types. By having a turntable or wye time can be saved by withdrawing for repairs but one cab or unit of a locomotive composed of two or more units, and the substitution of another cab to make up a complete locomotive, thus keeping the maximum number of complete locomotives in service, and at the same time handling the repairs on the out of order cabs to the best advantage. In making such exchanges and also to equalize flange wear, it often becomes necessary to turn a cab end for end.

Where electric power has been put in the field replacing steam either partially or completely, the complements of tools needed at the principal dispatching stations will be largely governed by the type of steam and electric locomotives used. Different methods of handling the running gear work at the outlying and principal stations in conjunction with operating conditions, set up problems that must be worked out or adjusted by the railroad to best meet the requirements.

A working pit supplied with a suitable drop pit for wheel and truck work is a convenience that might be considered common to steam as well as electric power, and is as convenient at the general repair shops.

An overhead crane of greater capacity perhaps than used ordinarily at a steam locomotive roundhouse is practically a necessity, for lifting motors, transformers, rheostats, air compressors, and other heavy parts of the electrical machinery from the frames, either through the hatch in the cab roof or after the cab has been removed.

The tool equipment must be distributed between the principal dispatching station and back shop, depending on the distribution of the repair work between the principal dispatching station and back shop as well as on the relation of the shops and whether the principal dispatching terminal is constructed in combination with the back shop or as separate shops located some distance apart.

To handle the work on electric equipment at the dispatching station comparable with the work that would ordinarily be necessary on steam equipment the demands are nevertheless different, and the conditions might be better pictured by considering that in place of the locomotive boiler, steam cylinders, guides, cross-heads and valve gear on the steam locomotives, the electric locomotive carries motors, phase converters, control apparatus, rheostats, switches and relays. In place of the steam locomotive cross head, certain types of electric locomotives have the jack shafts, gears or spring quills through which the power of the motor operates the locomotive. On an electric locomotive having the same general type of steam locomotive frame and wheel arrangement, the driving boxes, shoes and wedges, and brake rigging are practically the same. The side rods on an electric locomotive are practically the same as on the steam locomotives.

For electric locomotives having gear drive and motor armature mounted on the driving wheel axle, the maintenance work on the gear in a general way takes the place of operations corresponding to side rod maintenance. However, the total equipment necessary may be different.

The machine tools required at a steam locomotive dispatching station to maintain such parts would be practically the same for electric, and in the interest of handling the work to advantage, it has been found convenient to have at the principal dispatching stations tools such as a boring mill suitable for driving wheel centers and tires, a lathe of sufficient capacity to swing the largest motor revolving part, a 24-in. lathe, an intermediate size lathe for smaller motor repair work, a radial drill press, a slotter, vertical drill press, horizontal boring mill for bearings and bushings, press for removing and applying motor shafts and shaper, and facilities for repairing switches, relays, instruments, circuit breakers, etc.

For the major repair work which must be handled at shops corresponding to what are generally understood as back shops or shops where general repairs are made, some inexpensive changes might be made in arrangement of facilities and tools in an existing steam locomotive shop for the same general character of work on electric locomotives to improve the sequence of operations, as they differ somewhat between electric and steam power.

The boiler shop equipment can be eliminated, with the exception of a few tools for the rebuilding and repairing of transformers, rheostats, water and oil tanks and small boilers used on electric locomotives in passenger service.

In most steam locomotive repair shops, overhead cranes have been provided of sufficient capacity to lift a complete locomotive. A crane of sufficient capacity to lift a complete electric locomotive or one cab or unit composing an electric locomotive is desirable, where the design permits, though not always as necessary or as useful as for the handling of a steam locomotive. A crane, however, is quite necessary for the lifting of certain electric parts such as motors, transformers, phase converters, rheostats, and other heavy parts from the frames either through an opening cut in the roof of the cab, or after the cab has been removed. Under the crane should be provided a well lighted working pit, supplied with a suitable drop pit for driving wheels, removing main motors, truck, brake rigging work and similar work on the running gear.

There are many tools in use in the steam locomotive repair shop that might be well utilized in the maintenance of electric equipment, although on account of some of the electrical apparatus being rather special, there may be a demand for a greater number of small tools of special arrangement and design in order to handle small parts of motors, switches, blowers, etc. For instance, a boring mill for driving wheel centers and tire work, a lathe of sufficient size to swing the largest armatures or motors, small as well as intermediate size lathes, a radial drill press, a vertical drill press, a horizontal boring machine, a planer, a shaper and a driving wheel press should be provided. Lathes ordinarily used for piston work can be used for small motor shaft work. The smaller lathes and shapers can be used on a quantity of smaller electrical parts; maintenance of air compressors, dynamos, air brake work and other auxiliary units forming a part of the electric locomotive.

In addition to the equipment usually found in a well equipped locomotive shop, facilities must be added for armature banding, coil winding, press for handling armature shafts, etc. The armature and control repair department should, if possible, be conveniently located

adjacent to the machine shop in order to make the best use of the crane service and minimize the re-handling of motors and especially armatures on motors.

As a rule, existing steam locomotive shops with some slight rearrangement of facilities, are very adaptable for the care of electric locomotives. There are, however, great possibilities for economies in labor and time where new shops are designed for the exclusive care of electric equipment. A definite layout or complement of tools cannot be prescribed, as both depend entirely upon the general design of equipment used.

Electrification Progress

Progress made in the electric traction field during the past year was included as Exhibit No. 4. The new types of motive power units built were commented on and a large table included which lists electric traction installations used in all the principal countries of the world. This table includes a group of pertinent facts which charasterize each installation.

Electric Locomotives and Multiple Unit Equipment

A report listed as Exhibit 5 compares the relative advantages of the multiple unit system and electric locomotives for passenger service.

Possibilities of Wired-Wireless In Railroad Service*

CLOSELY akin to radio in some respects and yet differing very much in others, is the so-called system of wired-wireless or carrier current for communication.

About fifteen years ago experiments were conducted, which showed that wireless waves if applied to ordinary wires would follow wires substantially and would not leave them. It was further found that a large number of waves

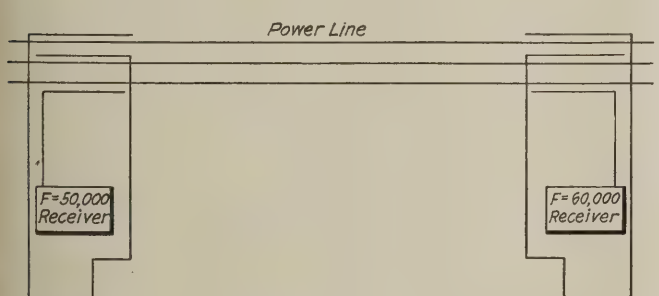

Fig. 1—Schematic Diagram Showing How Carrier Current Sets Operate Over Power Lines

could be applied to one wire and at the receiving end the waves could be separated from each other. It was thus found possible by the utilization of one wire or one pair of wires to hold several conversations and to accomplish numerous other operations.

The illustration Fig. 1 shows in a schematic way how carrier current sets are made to operate over power lines. It will be noted that the transmitter and receiver are each connected to so-called antennae wires which are actually wires insulated in themselves and suspended on the same towers that carry the high tension lines or the trolley wires and in close proximity to these wires. The length of these antennae are approximately 1,500 to 2,000 feet. The carrier current sets are connected so that they supply power to the antennae in much the same way that a radio transmitter works and it is found that practically all of the power thus supplied is transferred across the space between the antennae line and the power system. It thus travels along the power wires and is picked up by the receiving antennae along the line.

The illustration Fig. 2 shows a photograph of a complete carrier current telephone installation. When the telephone operator desires to call any other telephone

Fig. 2—Complete Carrier Current Telephone Installation

station he simply removes the telephone receiver from the switch hook and turns the little dial at the bottom of the desk stand to a certain number. This will ring any telephone on the system without disturbing any other unwanted phone. As soon as the man that has been called answers the two men are in instant communication just as if a wired telephone system were used and there are no wires between the two men other than those erected primarily for the purpose of carrying power.

There is another little device that has recently been perfected and which makes use of this same principle. With the advent of heavy electric traction a problem has developed in the operation of extremely long freight trains with many curves and using helpers or pushers at the rear end. It is important that the electric engines at both ends start and stop at the same time to get the best operation and to avoid waste of electric power. The method if signalling for simultaneous action by the use of an air whistle is not always effective since the electric freight trains are so long that such signals are misunderstood or are not heard at all.

A small cabinet is provided which attaches to the cab above the engineer. A rope hangs out of this cabinet and by pulling the rope down half-way the set is put in operation and the engineer can talk to the rear of the train. By pulling the rope all the way down a whistle signal is sent back. There are thus provided both a signalling system and a talking system.

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* Abstract of paper presented before the New York Railroad Club, by G. Y. Allen of the Westinghouse Electric & Mfg. Co.

Passenger Train at Maltrata Station. Note Welded Type Poles Made from Old Rails

Mexican Railway Begins Electrical Operation

Ten Electric Replace Twenty-Three Steam Locomotives and Schedule Speed Nearly Doubled

By W. D. Bearce
Railway Engineering Department, General Electric Company

ONE of the most important railroad electrifications completed during the past year was that of the Mexican Railway Company, Ltd., between the towns of Esperanza and Orizaba, Mexico. This section of the road is known locally as the Maltrate Incline, and is the limiting grade division of the main line between Mexico City and Vera Cruz. The first electric locomotives were delivered during the summer of 1924, and the service was gradually taken over until all steam engines were displaced in main line service in December. The steam engines used on this 30-mile division were known as the Firley type and were equipped for oil burning. These engines are double ended, have a three-axle driving truck at each end and weigh 150 tons with all weight on drivers. For handling the normal main line business before electrification, 23 of these engines were required.

Current at 3,000 Volts D. C.

The complete motive power equipment for electric operation includes ten 150-ton 3,000-volt direct current locomotives, used for both passenger and freight work. On account of the severe grades (4.7 per cent ruling, with a maximum of 5¼ per cent) and the heavy curvature, ranging from 12 to nearly 16 degrees, the speeds in this 30-mile section are limited for both passenger and freight work.

In the substitution of electric locomotives for steam on this road there are several unusual conditions. First, the steam engines replaced have identically the same weight as the electric locomotives now in use; second, they have all weight on driving wheels; and third, they operate equally well in either direction. In making the substitution, nevertheless, 10 electric units are replacing 23 steam.

The two principal reasons for the greater capacity of the electric locomotives are approximately double speed in service on the grades, and the higher percentage of availability. Whereas the electric locomotives are available approximately 90 per cent of the time, the steam locomotives would ordinarily be available only about 30 per

All of the Power Used Is Supplied by One Substation Equipped with Two 3000-Kw. Motor Generator Sets Located at Maltrata

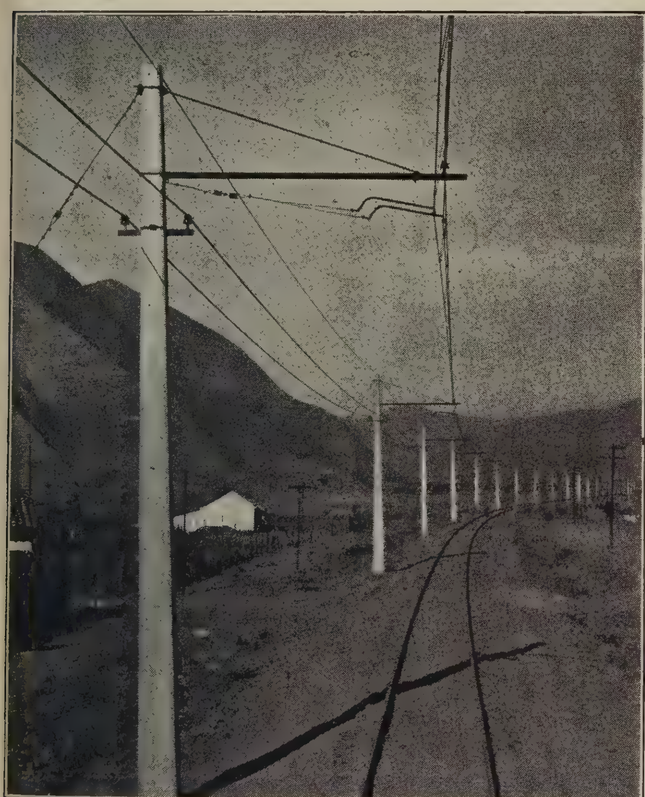
cent of the time. It has further been found that one electric locomotive can handle the normal passenger train of eight cars on the grade where two steam locomotives were formerly used. This is partly due to lack of steaming capacity for the long continuous pull, and partly to the faster schedule for passenger trains. The greater continuous capacity of the electric locomotives has also made

it possible to handle heavier freight trains with two electrics than was possible with two steam engines. Where two steam engines handled a 360-ton train, two electric engines are now handling a 660-ton train at a higher speed.

Great Reduction in Running Time

An analysis of the operating speeds on the up-grade run shows, for example, that one of the passenger trains which formerly required two hours and 50 minutes for the 30 mile run is now handled in one hour and 50 minutes, an increase in schedule speed of from 10.2 to 16 miles per hour. A typical freight run shows a decrease in running time of from four hours to two hours and 25 minutes, or an increase of schedule speeds from 7.3 to 12.1 miles per hour.

While it was not expected that much improvement in speed would be shown on the down hill run, as a matter of fact, the running time of most of the trains has been reduced. This is due to the elimination of stops for fuel and water and for cooling wheels and brake shoes. It will be appreciated that the schedule speeds above mentioned require an actual running speed, not including stops, which is approximately double that made by the steam equipment.



View of the Right-of-Way at Santa Rosa, Showing Bracket Type Concrete Poles and Twin Trolley

The officers of the road have expressed themselves as highly gratified with the operation of the electrical equipment. The initial operation of the electric locomotives indicates a vast improvement in operating costs over the oil burning steam locomotives. These reductions include saving of power over fuel, saving in brake shoes and wheels due to regeneration, and a general reduction in cost of maintaining equipment due to easier handling. A big reduction in the wage item of operating expense is also predicted, as a result of the increased speed of train movement.

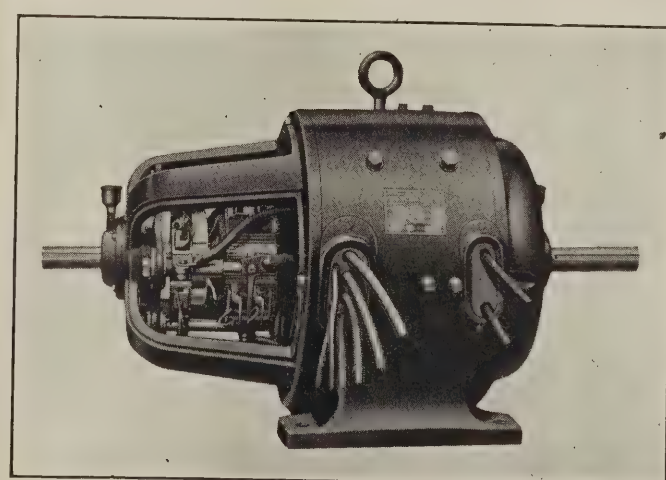
The entire 30 miles is fed from a single substation located at Maltrata. The equipment in this station has operated without interruption since the initial electric operation.

The overhead is of the twin conductor catenary type, using both concrete poles and a steel welded type made from old rails.

All of the equipment for this electrification, including the electric locomotives, the 6,000-kw. substation, overhead line material and bonding, was furnished by the General Electric Company. The Puebla Tramway Light & Power Company, which furnishes electric power for this road, has also purchased from the General Electric Company, a 11,250-kv-a. water wheel driven generator which will be used as additional equipment to its Tuxpango plant.

Two-Current Welding Generator

A generator which produces both alternating and direct current for electric welding has been developed and placed on the market by the Electric Arc Cutting & Welding Company of Newark, N. J. The same winding of the armature serves for both a.c. and d.c. so that no extra space is required. The only extra that is needed is two collector rings for the alternating current supply. The machine has been so designed that either the a.c. or d.c. leads can be short circuited at the collector rings or commutator without injury; the voltage falls to a value that holds the current constant and no injury is done to the generator while in this condition. As soon as the short circuit is removed, normal voltage is restored. The generator is equipped with ball bearings and has a power take-off at both ends for drive. The machine can be driven direct or by belt or chain from an electric motor, gas engine, steam engine or any other source of 7 hp.



Generator Designed to Supply Either Alternating or Direct Current for Welding

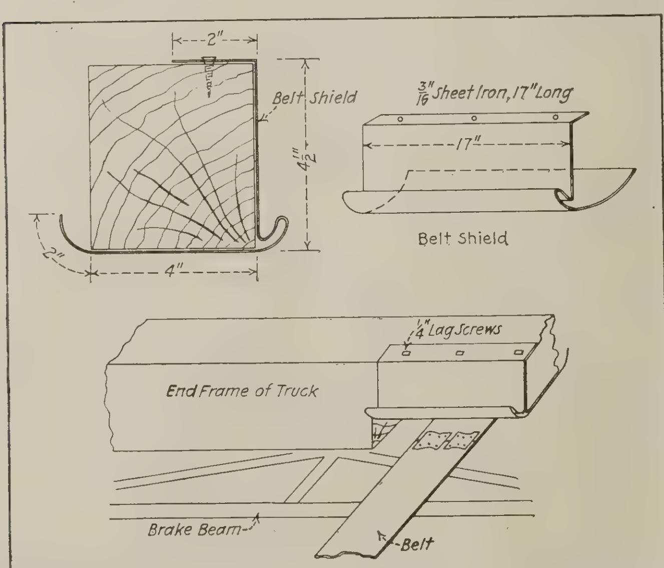
In the majority of instances this welding generator is driven by an electric motor directly coupled to the armature shaft.

A Shield For Car Lighting Belts

By W. W. Miller, Electrician Norfolk Southern Railway

I have read in the Interchange pages of the *Railway Electrical Engineer* of the different appliances used by some of the readers and the thought occurred to me to send in a description of a device which has proved very satisfactory to me. The device which I refer to has been very useful in overcoming trouble with belts on cars which have wooden truck frames, where the belt runs under the end frame. I have named the appliance I use a "belt shield."

Even after putting offsets in the truck frame for the car lighting belt to run under, it sometimes happens that



Sketches Show Details of Design and Application

we still have trouble with the belt clamps striking against the end frame of the truck. This may happen even though plenty of clearance was given at the time the equipment was applied at the shop, as in time the settling of the truck causes the end frame to be hit by the belt clamps, which results in the clamps being pulled out and the belt lost.

To relieve this trouble, I took a piece of 3/16 in. sheet iron 16 in. wide and 17 in. long and made a shield that fits over the end frame into the offset if there be one, or over the frame so that when the belt is running the clamps will strike a glancing blow and slip by.

A shoulder is made with a 2 in. flange that will fit over the top of the frame using 3/4 in. or 3/8 in. lagged screws to hold the shield in place. The front plate is 4 1/2 in. long which is sufficient to come down to the bottom of the frame member. This part of the shield is bent under to make a half moon which causes the clamp to strike a glancing blow as it passes. The sketches show clearly how the shield is constructed and applied.

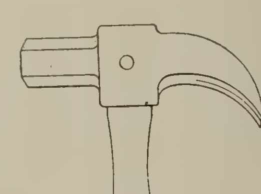
I have found this device very satisfactory and whenever I find a car on my division that is giving me trouble on account of the belt clamps pulling out, I apply one of these shields and the belt trouble from this cause disappears.

Good Taping Practice

The taping of form wound coils for motors, etc., if friction tape is used, is something of a tedious task, especially in some instances. On the other hand if high tension tape or varnished cambric, as it is sometimes called, is used, the troubles experienced in taping and those that develop in service, will largely be removed. This high tension tape is cut on the bias and when drawn over the ends of the coil, will curl at the edge. It can be drawn tighter than most friction tape and will not absorb as much moisture. It also provides better insulation. After the coil has been taped, it is dipped in medium thick orange shellac after which it should be allowed to dry for a day or two.

One Way to Fasten a Hammer Handle

After using innumerable wedges in an endeavor to hold the hammer head on the handle the following scheme was tried: After fitting the handle snugly in the hammer, a



Hammer Handle Riveted to Head

1/4-in. hole was drilled through the eye of the hammer and the handle. A 10d nail was placed in the hole, cut off and riveted to fit nicely. The result was very satisfactory and the hammer gave no more trouble, while the addition of the nail did not throw the hammer out of balance.

Thoroughly Blocked

A man traveling in a train that had made several abrupt stops and sudden jerks became a bit anxious. There had been numerous accidents on the line, so he had been told, and there was cause for fear. Calling the porter aside, he said: "George, is this train safe?"

"Safe as any, suh."

"Is there a block system on the road?"

George's grin extended from ear to ear.

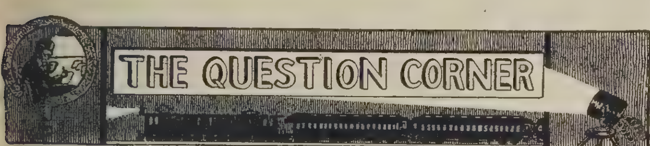
"Block system, suh? Why, boss, we has de greatest block system in the world. Ten miles back we was blocked by a load of hay, six miles back we was blocked by a mule, jes' now we was blocked by a cow, and I reckon when we gets farther south we'll be blocked by an alligator. Block system, suh? Well, I'll say it is!"

Plenty

"How often does your road kill a man?" asked the magistrate of the railroad guard. "Just once," replied the guard.

You See Them at the Crossing

A news item says that—"Our insane asylums are full and overflowing." If you doubt that, just watch the overflow race the trains to the crossing.



Answers to Questions

1: *Why is it that pure zinc will give a dry battery very long life, whereas impure zinc will give it short life?*

2: *What happens when the plates of a battery sulphate and what causes this sulphation?*

3: *How can you tell when the plates have become sulphated and what should be done with them?*

Some Battery Problems

1. The reason why pure zinc will give a dry battery long life may be explained as follows:

The usual impurity in zinc is carbon or lead and even a slight carbon particle on the surface of the zinc, coming directly in contact with the acid or electrolyte would have an effect exactly the same as if the carbon, or positive pole of the battery, had been connected to the negative or zinc pole by a copper wire. Current would flow from zinc to carbon and the zinc would be rapidly eaten away by the electrolytic action. Lead impurities would act in exactly the same way, but not quite so vigorously on account of the lower potential between lead and zinc plates. Pure zinc can be left for sometime in acid without being affected to any great extent.

2. In speaking of sulphation, we refer to the formation of white insoluble lead sulphate formed by the action of the sulphuric acid on the active material of the plates. This should be distinguished from the soluble lead sulphate formed in the plates every time the battery discharges.

This latter is not injurious to the plates, but the former, the white sulphate, is harmful. It is an insulator and as the particles of active material in the body of the plates are converted into this white sulphate, we not only lose in capacity by the amount of active material actually sulphated, but this sulphated material acts as an insulator to prevent current from flowing to or from other particles of active material. Sulphation may be due to any of the following causes: (a) Over discharge. (b) Standing in discharged condition. (c) Local short circuit or leakage, due to grounds. (d) Impurities in the cell. (e) Lower charging rate in the Planté type plants or the omission of an occasional overcharge. (f) Allowing the level of the electrolyte to get far below the tops of the plates.

3. As lead sulphate of the insoluble sort is white it is easily recognized. When it forms on the plates, it makes the active material turn slightly grayish or even white in bad cases. The sulphate may be also included by formation of grayish, brown patches on the plates.

If it is found that only one or two cells are in a sulphated conditions, remove them from the battery and replace them with duplicate trays; if it is a car lighting battery and the car must go immediately back into service; then remove the elements from the jars. It will usually be found that there is a short circuit on the plates in that particular cell due to deep sediment or to tree formation through the separators between the plates, remove the sediments or ground, give the cells one or two overcharges at normal rate until the plates gas freely. This should be sufficient to break up the sulphate formed and converted back into acid and live active material. Do not under any circumstances add acid to bring the gravity up. It will be found that as the sulphate is decomposed by charging the gravity of the acid will come up of its own accord.

If all of the cells of batteries are in a sulphated condition, it is likely due to having stood in a discharged condition. If the plates are only slightly grayish, it may be possible to break up this white sulphate in the plates by two or three overcharges, each carried until the battery gases freely and followed by successive discharge. If the plates are badly sulphated, as indicated by a very light gray or white color, it will probably be necessary to remove the battery from the car and give it several complete charges and discharges in order to bring it back to full capacity.

Some battery operators advocate the use of alkaline treatment for reducing sulphated plates, but the battery manufacturers state that this does not have any real advantage. For the sake of those who wish to try this method, we give it here as follows:

Remove the plates from the tank and rinse in water; then place them in clean tanks and pour a solution of pure caustic soda of a specific gravity of 1.200, formed by adding pure stick caustic soda to water; connect the plates in the usual manner and charge at the normal rate. It is said that one charge of soda is usually sufficient to break up the worst case of sulphation.

Questions for July

1—*How can you tell when the electrolyte of a cell is contaminated with iron impurities?*

2—*Explain just how iron impurities in electrolyte causes the local discharge of a cell?*

3—*How can you tell when a cell has copper in the electrolyte?*

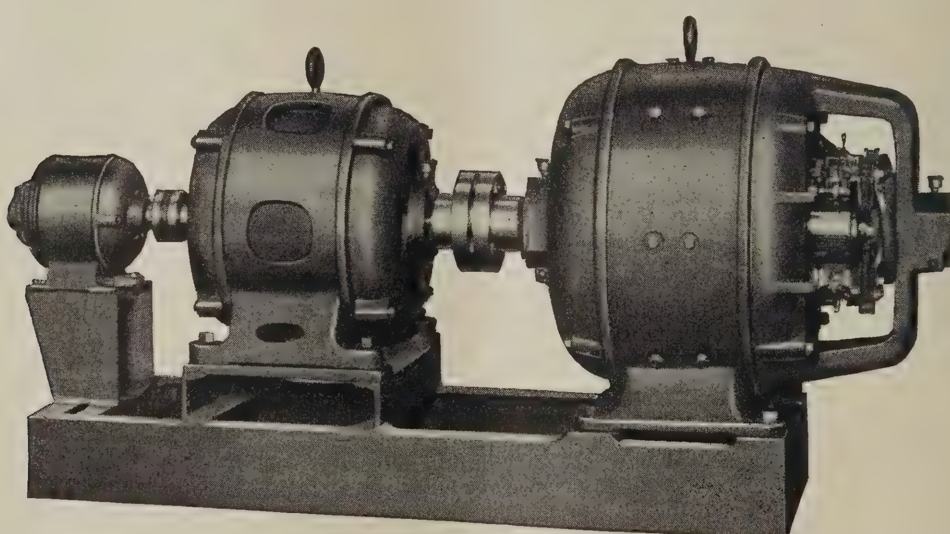
NEW DEVICES

Arc Welding Generator

A new type of arc welding generator has been developed recently, known as the Hansen arc welder, manufactured by the Northwestern Mfg. Co., Milwaukee, Wis., with a stabilizing winding built into the field structure, eliminating the necessity of any external stabilizing devices. This condition is obtained by a novel disposition of the commutating winding whereby several turns of the commutating pole coils have been extended to and completely embedded in the adjacent main pole flanges as shown in the illustration. The extended portion of the commutating winding surrounded by the laminations of the main field pole, functions in the two-fold capacity of commutating winding and stabilizing winding.

The illustration shows the field structure of the Hansen welder and it can be seen that the stabilizing winding consists of part of the commutating pole winding which has been extended to and embedded in the adjacent pole flanges. That is, the sum of the number of turns on the stabilizing winding and the commutating pole winding is equal to the number of turns that would ordinarily be employed on the commutating pole winding alone. When a current flows in the stabilizing winding a magnetic flux will be set up in the main pole shoes, the lines of force encircling the conductors of the stabilizing winding. When the current is increasing the flux is increasing and induces a voltage opposing the current flow. When the current is decreasing the changing flux induces a voltage assisting the current flow. The flux set up in the pole shoes by the current in the stabilizing winding induces a voltage in the right direction for stabilizing purposes. This action of the stabilizing winding in no wise interferes with its function of producing a commutating flux in the commutating zone.

By augmenting the saturation of the leading pole horns, due to cross-magnetization, the stabilizing winding is also instrumental in causing a weakening of the main flux with increasing load. It thus functions as a differential series field, which action is so sufficiently marked that the regular differential series field is cut out of the circuit altogether for large values of welding current.



The Motor, Generator and Exciter Are Mounted on a Common Base and Connected with Flexible Couplings

Two sizes of Hansen welders are being marketed, the small machine having a current range from 60 to 350 amperes, the large machine, a range from 90 to 400 amperes. For continuous welding duty the small machine, intended mainly for metallic electrode work, but also used for light carbon arc work, has a capacity of 250 amperes, and the corresponding rating of the large machine, intended for both metallic and carbon electrode

work, is 300 amperes. For intermittent welding duty the large machine is rated at 400 amperes. Fine adjustment of welding current is obtained by means of a rheostat in the separately excited field. With the Hansen welder it is said that an unusually fine penetration is obtained on cast

Field Pole Construction of Hansen Arc Welder

iron in addition to satisfactory performance on the usual applications of welding of ferrous metals.

Each unit of the welder has two ball bearings and is equipped with flexible couplings between units. It is claimed that this construction is much less liable to alignment troubles and is more readily taken apart for repairs than if motor, generator and exciter armatures were mounted on a common shaft.

Lincoln Steel Motor

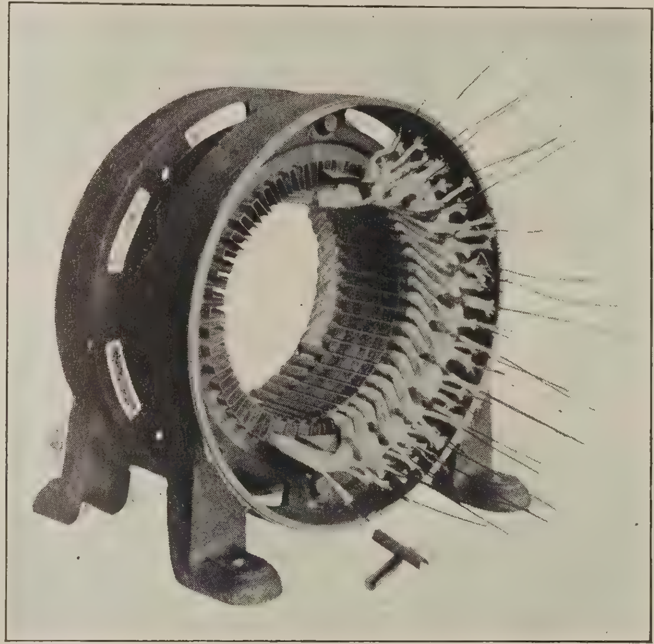
Through the application of a patented welding process, which the company calls the Linc-Weld Process, the Lincoln Electric Company of Cleveland, Ohio, has been enabled to put a new type of steel induction motor on the market. The new product differs from the usual type of motor, in that the frame and various other parts of the machine are made of rolled steel instead of cast iron or cast steel. The result is a motor of light weight, greater power per pound of weight, and good ventilation.

The end rings or the frame of the new motor are made from standard steel angles, the angles being rolled on a special machine designed for the purpose. This type of end rings has eliminated all breakage such as has been experienced in the past where cast iron was used. The fact that there is the least possible obstruction to air spaces is said to be one of the main contributing reasons for the new motor's ability to stand overloads.

The stator is made of thin sheets of steel or steel laminations which are stacked under great pressure between two steel rings. While they are compressed in this way they are hot riveted together. This insures against any possible loose laminations.

The end rings of the rotor are made from strips of pure copper bent into circular shape and welded in much the same way as the steel frames. The end rings are then punched and put over the drawn copper rods, which have already been inserted in the rotor, and which slightly protrude. The rotor is then placed in a special designed machine where the rods and rings are solidly welded together. Heavy ventilating vanes are welded to the rotor plate. The wire used in these motors is first insulated by a coating of enamel and also by covering with cotton. Two of these wires twisted together will in themselves resist a test of 2,000 volts without short circuits.

On the smaller sizes of motors there are stator laminations with semi- and closed slots. This gives a more



Induction Motor Stator Made of Rolléd Steel with Lugs Welded on

even distribution of the magnetic flux or field. Coils are wound on pins and stretched to shape, the ends or exposed parts are fully tapped and the tape is extended so that when the coils are placed in the stator, the tape extends clear into the iron, leaving the wire exposed.

Screw Ring Socket

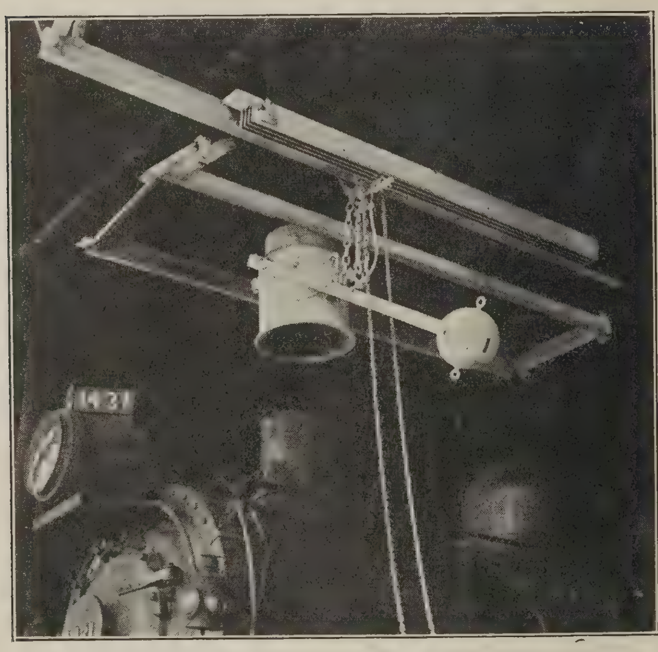
The Bryant Electric Company, Bridgeport, Conn., has recently improved its line of screw ring sockets by the addition of knurling to the ring. These sockets have a shell and cap which is held together by a ring which slips over the shoulder on the cap and is threaded to the body of the shell. This makes a secure fastening which will not jar loose when a heavy shade is hung from the shell. It is made for use in places where large metal or glass shades are fastened to brass shell sockets which are hung on surfaces subject to vibration. The sockets which have this style of shell are known as Titan sockets and are made with ⅛, ⅜-in. and pendent caps of the key, keyless and pull types. Except for the shell, cap and screw ring, the sockets do not differ from the standard Bryant brass sockets.

Screw Ring Socket with Knurled Ring

Blower for Drafting Locomotives in Enginehouse

Every time the steam pressure in a locomotive is let down, it is necessary to draft it in the enginehouse so that it can pull out under its own power. The present method of drafting a locomotive is to connect the engine steam line to a steam jet blower located at the bottom of the stack. The Coppus Engineering Corporation, Worcester, Mass., has recently designed and placed on the market an electric operated blower known as the Locoblow which is a redesign of an earlier blower of the same type which was first introduced to the railroad field in 1923.

The motor of the blower is essentially the same in capacity and design as that of the earlier type and the whole unit is similarly suspended from an I-beam monorail. The new blower, however, is more compact and lighter in weight and is much easier to handle from the enginehouse floor due to a balancing feature which makes it possible to raise the machine through the entire range of lift by a light pull on a rope attached to the end of a counterbalance. It may then be rolled over the stack by means of pulling the endless chain in the desired direction and lowered down upon the stack by releasing the rope. Current from the

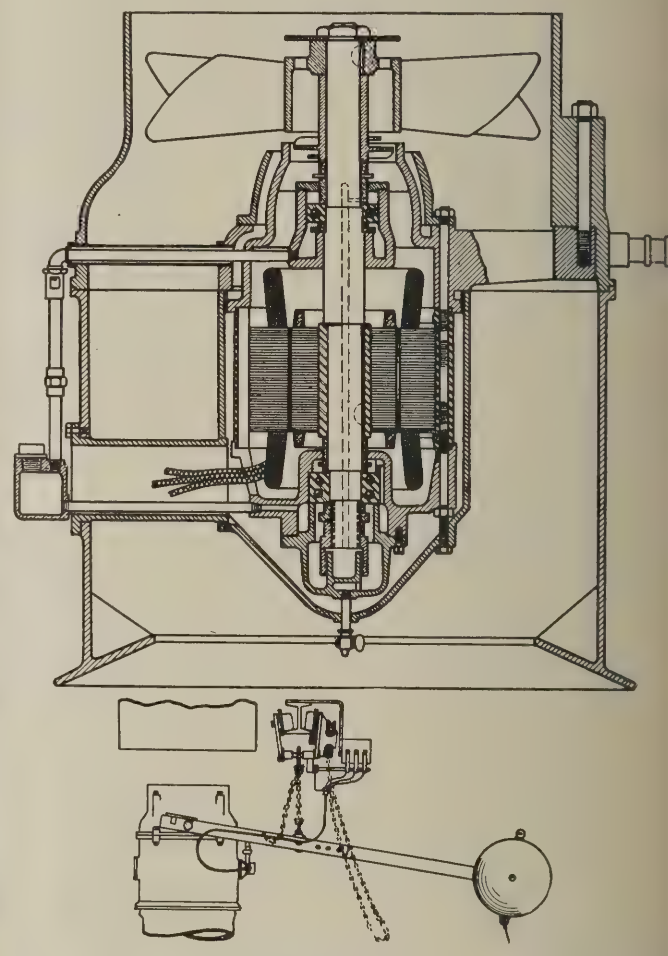


Motor Driven Locomotive Blower Which Can Be Placed Over the Stack or Swung Out of the Way by An Endless Chain

switch is led to three contact rails and from these rails is then carried to the motor through sliding copper contactors.

As some trouble was experienced with the earlier blower due to the lack of lubrication this feature has been given special attention in the design of the Locoblow, as will be seen by referring to the cross-sectional drawing. Oil is poured into the reservoir shown to the left until it overflows. This submerges the lower ball bearing and the oil-filling chamber below this bearing. When the blower is in operation the screw thread shown at the lower end of the rotating element pumps the oil through the hollow shaft to an outlet over both bearings. The oil which passes over the top bearing enters a reservoir immediately below from whence it is returned into the oil chamber by way of suitable piping.

As the motor is suspended in the center of the blower in such a way that the gases must pass around it, special attention has been paid to ventilation. The motor is encased and a strong current of air passes between the outside of the motor and this casing, this current being induced by the action of the main fan. Just below the main fan is located a smaller fan through the hub of the main



Cross-Sectional View Showing Arrangement of the Motor and Fan

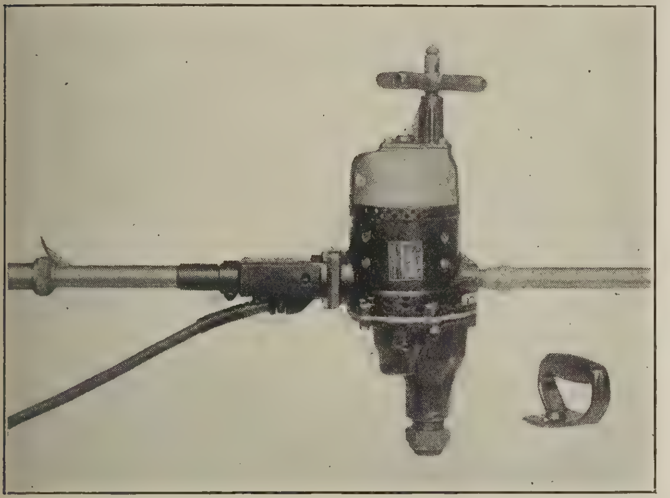
fan and the air which goes between the motor and casing surrounding the motor is discharged over the hub of the fan so that no great quantity of heat is transmitted to the shaft. The lead wires to the motor pass through one of the two tubes connecting the casing which encloses the motor with the fan casing proper. Care has been taken that none of the motor parts come in contact with the hot gases or metal parts heated by the gases so that the motor cannot be injured in this way.

The advantages claimed for this device are that it can be operated with much less noise and dirt; a more constant draft is induced due to being less subject to line fluctuations; the cost of firing up a locomotive is reduced and the work is done in much less time. It has been thoroughly tested in an enginehouse under normal conditions, which tests showed a saving of 15½ min. to get up 65 lb. steam pressure from cold water. A saving of 92½ per cent in the cost of firing up a locomotive was shown by the tests.

An Electric Drill and Reamer for the Car Shop

A direct current, compound electric drill and reamer for use in car repair work has recently been placed on the market by the Independent Pneumatic Tool Company, Chicago. It has a drilling capacity up to 1¼ in. and is especially suited for reaming 13/16 in, and 15/16 in. holes in steel car construction work. It has a maximum speed of 600 r.p.m. and weighs 60 lb.

Its construction has several features which lend to its adaptability for the work for which it is intended. The one-piece bridge and housing construction of the rear end of the machine provides easy accessibility and also carries the upper armature bearing in permanent alinement with the lower one. The motor is air-cooled through vents in the starter housing. These vents are not drilled radially, but are at a tangent to the fan blade's motion. The rectangular brushes are provided with a liberal area for the maximum of current they carry. The holder, which embraces the brush, draws the heat rapidly away from the commutator surface and spreads it throughout the brush assembly. The radiation, accelerated by the increased air current of the angular vents, carries off the heat from the brushes.



Thor Motor Driven Drill and Reamer Adaptable for Car Construction Work

To secure as nearly a perfect balance as possible, first the commutator and fan and then the complete armature are balanced separately so as to eliminate vibration. The commutator is not attached direct to the steel armature shaft because steel does not expand the same under heat as copper. The commutator is a separate unit, built up on a brass sleeve that expands and contracts evenly with the copper segments. Rectangular slots are used on the motor armature which allows the use of more wire and insulation which permits the usage of double silk-covered wires for the coils.

The gears in the motor are machine cut from alloy steel. The roller bearing assembly on the center plate stud provides support for the upper end of the spindle which eliminates strain and wear on the plain bronze spindle bearing at the lower end. The machine is equipped throughout with ball and roller bearings.

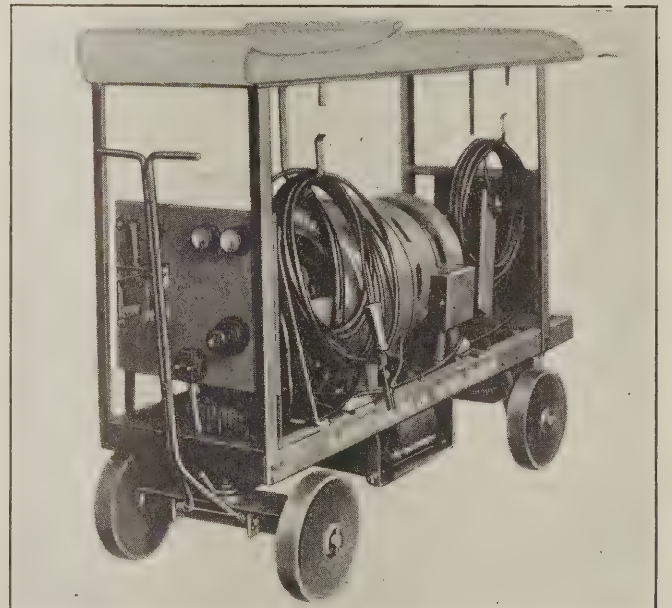
The tool is provided with a side handle switch which eliminates all wire connections between the switch handle and the motor. It is a separate unit and makes contact from the motor to the line by means of brass plungers. The cable is of the three-conductor type and leads into the handle through a supporting taper coil spring. A plunger type of switch is used which is located in the handle for the convenience of the operator.

Electric Welder Designed for Railroad Shops

An electric welder especially designed for use in railroad shops has been placed on the market by the Lincoln Electric Company, Cleveland, Ohio. The equipment is said to afford unusual ease of operation and to be especially well adapted to its particular field because of its relatively narrow width. It is 21 in. wide so that it will easily pass through the narrowest aisles in a shop. It is fully equipped with large roller bearings. This adds materially to its ease of mobility.

The center of gravity of the machine is low so that it will not be liable to tip over. The frame is of structural steel, extending beyond the equipment on the truck, so that it is almost impossible to back the truck into anything which would damage the welder. This is a desirable feature owing to the rough handling equipment of this nature receives in the railroad shop.

The welder, which is a 300-amp. arc unit, uses the stable arc. This arc will weld such jobs as locomotive frames, crosshead guides, truck sides, main driving wheels, journal boxes, etc. It is said that in actual tests, from four to five feet of fire-box seam has been welded in an hour; and that from seven to ten pounds of metal has been placed on a crosshead guide in one hour.



Portable Electric Welder Which Can Readily Pass Through the Congested Shop Owing to Its Restricted Width

The machine is provided with water-proof covers, which can be thrown back easily and which, when dropped down, provide complete protection from the weather. A push button starter, tool box, handy but out of the way, a spring controlled handle which is out of the way when not in use, convenient cable hooks, and light total weight are some of the other features of this equipment.

General News Section

The Interstate Commerce Commission has denied a petition of the Baltimore & Ohio for a further extension of the time specified for the fulfilment of its automatic train control order of June 13, 1922.

Oliver Electric & Manufacturing Company, St. Louis, Missouri, announces the removal of its Chicago office, 649 McCormick building, to Room 2140, Straus Building, at 310 South Michigan avenue. The office is in charge of W. A. Ross.

W. W. Ballew, electric railway specialist at Atlanta, Ga., of the Westinghouse Electric & Manufacturing Co., has been promoted to division manager in the state of Georgia, with headquarters in the Westinghouse building, 426 Mariette street, Atlanta.

The Chicago Electric Company, 740 West Van Buren street, Chicago, has been appointed district representative, for the sale of American mono-rail cable conveyors in northern Illinois and northern Indiana, for the Conveyors Corporation of America, Chicago.

Over 900 members of the Pennsylvania General Office Veteran Employee's Association, Philadelphia, went to Ocean City, N. J., on June 24, for their fourth annual outing. A special train was run for the accommodation of the party. Bathing, water sports, and other amusements were provided.

The Bridgeport Brass Company, Bridgeport, Conn., announces that L. W. Grout, formerly vice president and manager of the Keating Valve Company has joined the sales organization of the Bridgeport Brass Company to take charge of the Bridgeport-Keating flush valves which are now manufactured by the latter cmpany.

The U. S. Electrical Tool Company, Cincinnati Ohio, announces the appointment of the Backmeier Sales Corporation as manufacturers' agents to handle and promote the sale of United States Electric tools in the 14 southern states. The latter company has general offices located in Cincinnati and branch warehouses are established in Atlanta, Ga., and Dallas, Texas.

The Safety Car Heating & Lighting Company, New York, has entered into an agreement with the Silica Gel Corporation, Baltimore, Md., for the development under exclusive license, of apparatus for use by railroads and other transportation refrigeration generally. The Safety Car Heating & Lighting Company's engineers, after investigation have decided that the use of Silica Gel for refrigeration is sound and gives promise of extended use.

The French Battery Company, Madison, Wisconsin, is the name under which the French Battery & Carbon Company will be known in the future. At a recent stockholders' meeting a refinancing plan was adopted which will permit the company to increase greatly the output of its plant. In view of the fact that the company has decided to intensify on the production of dry batteries, it was decided to drop the word "carbon" from the company name.

The Westinghouse Electric & Manufacturing Company announces the creation of a new department for the handling of instruments. Heretofore instruments have been handled in the same departments as meters but the increasing growth of the meter business has made it necessary for the creation of a separate section. The new section will handle indicating, portable and recording instruments, relays and instrument transformers. R. T. Pierce, formerly of the supply engineering section will be manager of the new section, with headquarters at Newark, N. J.

Erie Railroad Company will convert its Monmouth street, Jersey City, coach yard into a team track yard and will build at Weehawken, N. J., a new coach yard. The company has acquired a portion of the warehouse property, adjoining its right of way in Jersey City, owned by the Safety Car Heating & Lighting Company. It has other large holdings in the vicinity and plans ultimately an extensive terminal warehouse development on the property, which is located at the New Jersey entrance to the Hudson river vehicular tunnels, now nearing completion.

The Chicago, Burlington & Quincy has issued a 32-page illustrated booklet entitled "The Story of the Burlington," in which it describes the growth and development of the system since the granting of the charter on February 12, 1849. The booklet shows the investment of money in the road's construction and equipment and the acquisition of roads up to the present time. The livestock, coal and beet sugar industries along its lines are described as well as fast mail service and railroad land grants. In addition, the booklet describes ways in which the Burlington has aided farmers.

Westinghouse Electric & Manufacturing Company

The annual report of the Westinghouse Electric & Manufacturing Company shows for the fiscal year ended March 31, 1925, gross earnings of $157,880,292 as compared with $154,412,918 in the preceding year. Net income available for dividends totaled $15,324,364 as compared with $16,125,303 in the year ended March 31, 1924. Comparison of gross and net earnings for the past three years follows:

	Year Ended March 31		
	1925	1924	1923
Gross earnings—sales billed....	$157,880,292	$154,412,918	$125,166,115
Cost of sales..................	144,242,065	137,006,280	111,694,832
Net manufacturing profit......	$13,638,227	$17,406,638	$13,471,283
Other income.................	4,203,179	1,336,438	1,296,601
Gross income from all sources..	$17,841,406	$18,743,076	$14,767,884
Interest charges, etc..........	2,517,042	2,617,773	2,504,398
Net income available for dividends and other purposes....	$15,324,364	$16,125,303	$12,263,486

The decrease in the total value of all orders booked was 5 per cent as compared with the previous year. The orders for incandescent lamps and radio apparatus substantially exceeded last year. The value of unfilled orders at the close of the fiscal year was $55,271,908, compared with $63,738,702 at the close of the previous fiscal year.

Boston & Maine to Improve Passenger Service

The Boston & Maine will increase the speed of passenger train service in several instances and add new trains to provide for heavy seasonal travel to the many resorts along its lines in a new time-table effective June 29.

Between Boston and Portland, Me., in both directions, certain trains are scheduled from 5 to 15 minutes faster than before. It is over this route also that the Boston & Maine Transportation Company is to establish shortly the first of the long distance highway motor coach services announced some time ago. The effort to improve the advantages of travel by train by shortening the running time is noticeable also on other runs, trains between Boston and Concord, N. H., being scheduled from 3 to 8 minutes faster in some cases, with savings in time also between Boston and Manchester, N. H., and Boston and Nashua, N. H.

Rock Island to Spend $20,000,000

Twenty million dollars will be spent by the Chicago, Rock Island & Pacific during the current year for additions and improvements to its line and equipment. The program provides for 42 miles of second track in Kansas, to cost $3,700,000; a 33-mile branch line in Oklahoma to cost $990,000; coal and water facilities at various points in Iowa to cost $1,000,000, and improvements on the El Paso division, including a passenger station, at Tucumcari, N. M., to cost a total of $310,000. The total expenditure of $8,600,000 will be made in the laying of new rail, track elevation, elimination of grade crossings, and for shop machinery and improvements to locomotives and cars. New locomotives and cars to the amount of $5,100,000 will be purchased, and $2,230,000 has been appropriated for the rebuilding of refrigerator and coal cars. Orders for equipment authorized have already been placed, and part of the other work has been completed or is in progress.

Atlantic Coast Line to Spend $10,500,000

The Atlantic Coast Line has authorized the expenditure this year of about $10,500,000 for betterments to its transportation facilities. This includes the cost of completing double track on the main line between Richmond and Jacksonville which will be finished in the autumn of 1925, and will bring the amount spent or authorized for improved facilities since the end of federal control up to approximately $66,500,000. The improvements to be made this year include the extension of many sidings, the construction of additional team and industrial tracks, enlarged yard and shop facilities at a number of important points, new coaling and water stations, the purchase of 60 new locomotives, 500 steel underframe 40-ton box cars, and 200 fifty-ton all steel phosphate cars, together with other miscellaneous rolling stock, and 55 thousand tons of 100-lb. rail.

At Tampa, Fla., over $500,000 will be spent in constructing new shops and terminals. In the future all freight and passenger trains, except those bound for Port Tampa, 10 miles to the west, will be handled at the new Uceta terminals. The transportation and classification yard will include about 10 miles of track with capacity for 610 cars and room for expansion to accommodate at least three times this number. There will also be erected a 12-stall roundhouse, a machine shop, storehouse, blacksmith shop, 500-ton coaling plant, a cinder hoist, water softening plant, 100-ft. turntable, coach washing tracks and various other facilities. Work is actively under way on this project.

Other major items which have been authorized include the deepening of the channels at water terminals at Jacksonville and Port Tampa, new coaling stations at Collier, Va., Fayetteville, N. C., and Trilby, Fla., and the installation of telephone service for use in train dispatching between Jacksonville and Port Tampa and between Lakeland and High Springs, Fla., and reconstruction of an important interlocking plant at Ashley Junction. Extensive additions are to be made to existing shop facilities at Lakeland, Fla., Waycross and Albany, Ga., Montgomery, Ala., Florence, S. C., and Rocky Mount, N. C., and a salvage plant is to be established at Southover Shops, Savannah, Ga. The total cost of improvements to mechanical facilities will be more than $800,000. Enough 100-lb. steel rail to relay about 370 miles of line has been ordered. At Thomasville, Ga., Montgomery, Ala., and Lakeland, Fla., 100-ft. modern turntables will be installed. A water softening plant will be erected at Moncrief Shops, Jacksonville, Fla.

Changes in U. S. L. Organization

The U. S. Light & Heat Corporation announces the following changes in its organization. H. A. Matthews, vice president of the railway sales division has been transferred to the post of resident vice president at Detroit on account of the growth of the company's business in this territory. This does not conflict in any way with the present Detroit organization where W. W. Pennington will continue as sales manager. J. A. White, vice president, sales manufacturers division, will personally supervise all railway sales with R. J. Stanton, sales manager in direct charge. J. L. Fosnight, sales manager, arc welder division, will handle the sales of U. S. L. welders to railroad and industrial concerns. A. W. Donop, district sales manager, Chicago, will have charge of the railway sales in Chicago territory, vice H. A. Morrison, resigned. The railway sales office at 1404 Railway Exchange will be discontinued by consolidation with the battery sales office at 2001 West Pershing Road. The New York office with W. W. Halsey continuing as district sales manager has been moved from Room 5617 Grand Central Terminal to 161 West 64th Street.

Railway Expenditures in 1924

Expenditures made by Class I railroads in 1924 for wages, materials and supplies and for improvements totaled $4,847,700,000, according to reports compiled by the Bureau of Railway Economics. The principal expenditures were divided as follows:

Wages paid for maintenance and operation	$2,629,902,000
Materials purchased, including fuel	1,343,055,000
Capital expenditures (including new equipment and improvements)	874,743,000
Total	$4,847,700,000

This amount, however, does not include approximately $340,000,000 paid in taxes, or an average of $929,000 daily compared with a daily average of $909,000 in 1923. It also does not include $510,000,000 paid out in interest charges or $310,000,000 paid out in dividends.

The total principal expenditures of the railroads in 1924 showed a decrease of $735,400,000 as compared with 1923.

Electrification and Extensions Planned by South Indian

An estimate of about 33,000,000 rupees for the electrification and double-tracking of the lines of the South Indian Railway, in the suburbs of Madras, has been sent to the home board by the authorities of the railway at Trichinopoly; upon a reply, expected shortly, the estimate will be forwarded to the railway board at Delhi for the necessary sanction, according to Commerce Reports.

The program calls for the laying of 1,100 miles of new railway within the next five years, or about 200 miles a year. A part of this scheme has already been approved by the railway board.

Electrification Progress Reported in Soviet Russia

A beginning has been made on the electrification of the railways of the Soviet Union, according to bulletins received from Moscow by the Russian Information Bureau in Washington. Several of the Moscow suburban lines are being electrified, and also the Suram mountain pass section of the Transcaucasian line, between Tiflis and Batum. In all 94 miles are being brought to completion. An additional 105 miles will shortly be begun, including the electrification of the Leningrad suburban lines. The general electrification program, it is said, calls first for the electrification of suburban and mountain lines and eventually for the establishment of electric trunk lines adapted to the transport of trains up to 7,000 tons.

Personals

H. A. Morrison, formerly district manager in charge of railway sales at Chicago for the United States Light & Heat Corporation has entered the business department of the Simmons-Boardman Publishing Company, publishers of the *Railway Electrical Engineer,* with headquarters at Chicago. Mr. Morrison was born in Indianapolis, Ind., on December 21, 1892, and after completing his high school education at Indianapolis, he studied electrical engineering at Purdue University, Lafayette, Ind., from 1910 to 1912. His first railroad experience was obtained in the traffic department of the Pennsylvania railroad at Indianapolis, entering the service of this road in 1912. In August, 1915, he left the Pennsylvania to enter the service of the Chicago, Rock Island & Pacific as a special apprentice at Silvis, Ill., in power plant and electrical work. He was transferred to the general mechanical superintendent's office at Chicago in June, 1918. On September 1, 1919, he left the Chicago, Rock Island & Pacific to enter the service of the United States Light & Heat Corporation as a sales engineer in the Chicago office. He was appointed district manager in charge of railway sales of this company on May 1, 1924, which position he held until his recent appointment to the business staff of the Simmons-Boardman Publishing Company.

H. A. Morrison

Trade Publications

Veritys, Ltd., Birmingham, England, has recently issued a small electrical pamphlet of 16 pages, showing many interior views of its shops. The bulletin points out that the company manufactures motors both a.c. and d.c. which range from ¼ to 500 hp.

The Electric Controller & Manufacturing Company, Cleveland, Ohio, has just issued its bulletin No. 1048 describing type ZO starting switches for small a.c. motors. The type ZO device is a new push button, operated oil switch for squirrel cage and single phase motors.

Herman H. Sticht & Company, New York, has just published an 8-page illustrated booklet known as bulletin No. 130 which describes the model "D" megohmer, an instrument designed for testing insulation resistance. A number of diagrams are shown indicating the range of possibilities in the use of this instrument.

A résumé of the uses and value of automatic arc welding, together with a description of the welding apparatus and generating equipment used, is given in a bulletin bearing the number 48937.1 and entitled "Automatic Arc Welding," recently issued by the General Electric Company. This is a 20-page, paper bound booklet, illustrated by photographs of equipment and actual applications.

The Roller Smith Company, New York, has recently issued bulletins No. 400 and 530. The former describes in detail direct current switchboard instruments, including ammeters, milli-ammeters, volt meters, milli-volt meters and voltammeter. The second bulletin shows diagramatically and describes the operation of a circuit breaker which is designed with a "non-closable on overload" feature.

"High Speed Induction Motors and Frequency Changers" is the title of a 27-page bulletin (No. 41521-B) recently issued by the General Electric Company. This booklet, well illustrated by photographs, diagrams, tables, etc., presents a complete line of motors, alternators and frequency changers adaptable for application on modern high speed woodworking machines and those forms of machine tools requiring high speed drive.

Bulletin No. 47640.2, devoted to induction, time, overcurrent relays, types IA-201, IA-202, IA-205 and IA-206, has been issued by the General Electric Company. It describes the four forms of over-current relays, together with the applications of each. Details of construction, lists of available ratings and principles of operation are covered, together with other general information. The bulletin is illustrated by photographs, charts and diagrams and contains 15 pages.

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Charging Convention Sleepers

At certain periods of the year a number of roads are confronted with the problem of charging convention sleepers. These cars are placed at some point in the yard and are used to house delegates during the time of the convention. Usually the location selected for placing the cars is remote from any source of current suitable for lighting them or keeping the batteries charged.

Alternating current is often available, but this usually means that all of the lamps in the cars must be changed and all fans disconnected. Also there is no source of supply for keeping the batteries charged and care must be taken to keep the alternating current from being applied accidentally to the battery. Roads that use head-end lighting and have baggage cars containing charging sets available can keep the trains lighted with these, but it means tying-up baggage cars and usually at least one locomotive. With the advent of electric welding, the problem is made easier as a welding set will supply the kind of current that is needed. The set is usually portable and it is usually possible to release a set for special service of this kind.

Each new application of electricity on the railroads appears to complicate the position of the railroad electrical engineer, but the foregoing example is one which shows that the reverse is also frequently true. When there are many different kinds of apparatus available, equipment from one branch of the electrical department can often be used for emergencies in others. The electrician no longer needs to exercise his ingenuity as much as formerly in trying to get along without something that he needs badly.

Good Lighting Increases Production

The relation between light and vision is one which is frequently not understood by those who are responsible for lighting arrangements. It is apparently so easy to lay out the lighting in a shop by means of arbitrarily assigning lamps to certain locations that it often happens, the care and consideration which should be given to the work is partially, if not entirely, omitted. There is unquestionably a correct method of lighting for each space to be illuminated and it is likewise true that there are many inferior ways. If the lighting arrangement, if properly designed, so that there is an absence of glare in the eyes of the workman, while at the same time there is an abundance of illumination to carry on the manufacturing processes, then the installation may be considered a success. This may mean a considerable increase in the money spent for electric current, but actual tests have time and again proved conclusively that the results obtained paid for the extra illumination many times over.

In an article, "Important Relation Between Light and Vision," which appears elsewhere in this issue, some very interesting figures are given showing just what was accomplished in one instance where lighting conditions were improved.

Although there has been much publicity on the subject of adequate light which is strictly applicable to railroad shops and buildings, there is still many of these places which are improperly and insufficiently lighted. The right location for the lighting unit cannot be arrived at by snap judgment but should only be determined after careful consideration has been given to all of the factors. If care and thought are taken in planning shop lighting the result will be reflected and more cheerful surroundings and a very substantial increase in production.

Some Results of Electric Welding

Electric welding is finding increased application in many operations in railway car and locomotive shops, particularly shops doing a large amount of welding. One road whose management was not in a position to spend any money in order to save money, regardless of how large such savings might be, was induced by a manufacturer of electric welding equipment to install machines and pay for them out of the savings effected. This was worked out to the satisfaction of both parties, even though in arriving at a suitable basis of determining the monthly savings the highest of several estimates was used to determine the cost of the electric welding. Electric welding on this road has grown during the past year from a deposit of 300 lb. of metal a month to almost 4,000 lb. a month, and it is estimated an annual saving of over $50,000 is being realized without capital expenditure for new equipment.

Another road, which at the beginning of 1924 had 31 portable electric welding machines in service and purchased 58 additional machines during the year, saves about $3,000 a year with each machine, or a total of approximately $270,000 annually. This represents a return estimated conservatively at 200 per cent a year on the expenditure for equipment. This road is now doing all welding of steel on locomotives and cars with electricity at the points where these machines are installed and is at present experimenting with the electric welding of cast-iron.

A further railway application of the electric arc, and one which in the relatively few installations now operating

has demonstrated its practicability and economy, is the cutting up of steel cars and scrap with the carbon arc. This is a relatively new practice still really in the development stage. Some of the problems are being studied jointly by the railroads and the manufacturers, and one plant of 2,000-ampere capacity now under construction at a large reclamation yard is nearing completion. One of the difficult problems is the design of a suitable holder to handle the extremely large currents; another difficulty with the arc in cutting castings of considerable thickness is the disposition of the molten metal; and a further handicap as at present developed is the increased time required as compared to other cutting methods. It must be admitted that these problems are not easy of solution and yet those who are working on them are confident that a satisfactory method of using the carbon arc will be developed and furthermore that the net economies will be large enough to warrant additional installations in railway shops and reclamation yards.

High Voltage Flood Lighting Feeder

There have been numerous installations of flood lighting in classification yards in recent years, but for the most part these have been more or less similar in their general characteristics. In the majority of yards lighted in this manner, relatively low voltage circuits have been used to supply current to the lighting units, so that an installation which makes use of a 11,000 volts, 3 phase line for distribution is something of an innovation. At the classification yards of the Lehigh Valley at Manchester, N. Y., such a line has been put into service and the result has been highly satisfactory.

Ordinarily such high voltage would be quite unnecessary for yard lighting, but in this particular case there are extenuating circumstances which not only make an installation practical, but economical, for in addition to the flood lighting referred to there are many other uses in the yard for electric energy.

The question which such an installation gives rise to is whether it is better to install separate circuits for yard lighting or to include such lighting on the same circuit with other facilities. In the final analysis the solution of almost any problem is usually the method which is least expensive to install and maintain, all other things being equal. A lighting voltage of 11,000 volts seems rather high for flood lighting alone, but when it is considered that very large loads are supplied from the same line it is of course, justifiable to adopt this relatively high voltage. It is true that in an arrangement of this kind it becomes necessary to install manually operated switches at each flood lighting tower, but inasmuch as there are men working in the vicinity of the towers at practically all hours, this is not a particularly objectionable feature. Certainly the cost of copper for supplying large loads on the line other than flood lighting is very much reduced when the voltage is as high as 11,000.

The success which this yard has had proves conclusively that the scheme is practical, and at the same time it is strongly indicative of the modern tendency to adopt high voltage for distribution to small units. It is interesting to note that engineers are becoming less reluctant to use higher voltage for such work and it is more than likely that there are other yards which could be supplied with electric energy in the same or similar manner.

The Oil-Electric Locomotive

The oil-electric locomotive has now been in service for about a year and a half under a variety of service conditions much more severe than would have to be met were it used by any one railroad. In most classes it has been pitted against steam locomotives of about its own weight and these have included both geared steam locomotives and locomotives used in passenger service. In practically every case the oil-electric has done equally well or better than those it displaced in spite of the fact that the power unit is rated at only 300 hp.

Test results show the locomotive to be dependable and show that maintenance costs can be expected to be very low over a period of years. Operating costs are remarkably low. Excepting conditions where traffic is very heavy and a concentration of power is necessary, the first cost of the oil electric locomotive, and also the operating cost, would apparently be less than for electric locomotives which receive their power from a stationary power plant. In addition to this the operating range of the oil-electric is not restricted by the necessity of an overhead trolley.

The inherent advantages of the oil-electric locomotive lie in the high efficiency of the Diesel engine coupled with the characteristics of the electrical apparatus which permit all of the power of the engine to be used at any locomotive speed. The same locomotive which can make a heavy switching movement at six miles an hour can also, if necessary, be run at practically passenger train speed. Furthermore, the locomotive during the period of its testing has been available for service a remarkably large proportion of the time.

The first cost of the oil-electric locomotive is high as compared with a steam locomotive of the same size. In addition to this it is handicapped by entering the small locomotive field at a time when most railroads have more small steam locomotives than they can use to advantage. These factors, however, will in many cases be more than offset by the outstanding advantages of this new type of motive power. The oil-electric locomotive has apparently come to stay and should be considered as one form of electrification.

New Books

Railways of the World, by F. A. Talbot. 2 Volumes, each of 360 pages. 8 in. by 11 in. Profusely illustrated. Bound in cloth. Published by Simmons-Boardman Publishing Company, 30 Church Street, New York. Price, both volumes, $10.

This work is intended for the general reader. This does not mean that it is of no value to the man in active railroad service; quite the contrary. But, from his point of view, it is to be read for the purpose of securing information about the industry in a general way the world over rather than as an exhaustive technical or reference work.

The work, then, is frankly popular and non-technical, but it is nevertheless accurate and far from superficial. The subjects described were apparently selected largely for their popular appeal; yet many of them are doubtless unknown to the average railroad man on this continent and could not fail to interest him. Furthermore every subject treated is richly illustrated by reproductions from photographs—which adds greatly to the interest and effectiveness of the reading matter.

St. Paul Makes Study of Car Lighting Costs

Merits of Eleven Different Plans Are Compared—New Development and Annual Costs Are Determined

FOR the purpose of improving car lighting on the Chicago, Milwaukee & St. Paul a study of the different types of electric lighting that can be used was made by that railroad. The result of this study was a report which is one of the most comprehensive that has ever been prepared on this subject. It was prepared by R. Beeuwkes, electrical engineer, C. G. Lovell, assistant engineer electrification department, and P. S. Westcott, assistant car lighting engineer. The following is a brief summary of the report.

The report is intended to cover the general subject of train lighting as applied to the Chicago, Milwaukee & St. Paul. Its object is to show how present lighting of cars can be improved and second, how this can be done with minimum fixed and operating charges.

The present passenger train equipment consists of the following:

Total number of passenger train cars	1,604
Total number of electrically lighted cars	1,016
Total number of head-end and storage battery lighted cars	995
Total number of steam-driven generator sets	68
Total number of individual axle generator lighted cars	21

About 205 of the electrically lighted cars are equipped with 64-volt battery sets.

Systems in General Use

Practically all car lighting is accomplished by one of four general systems, namely, the head-end system such as is used on the Chicago, Milwaukee & St. Paul, the head-end axle generator system, the straight storage system and the individual axle generator system. Due to the extensive charging facilities required, the comparatively small permissible radius of movement on one charge, and unsatisfactory voltage regulation, the straight storage system was not considered.

Plans Considered

In order to arrive at a basis of comparison a study was made of past costs as of 1921 and 1922 including all cars lighted from head-end sets and headlight generators and on straight storage. The number of cars was taken to be 965 in assigned service including standby reserve, and therefore the number to which these costs are mainly chargeable. Number of head-end sets 68, number of batteries 205.

A second study was also made which included only those cars assigned in the more important trains plus a few trains on which the headlight generator system was found inadequate. It is based on past costs as of 1921 and 1922 covering the 610 cars now electric lighted by head-end sets, headlight generators, axle sets and straight storage with four hundred thirty-six cars in daily active service. Number of head-end sets 66, number of batteries 190.

Eleven different plans for improving electric car lighting were considered. These plans are as follows:

Plan 1. Chain-driven head-end system similar to Simplex system used on Northern Pacific but with batteries and regulators on all first class cars; 37 sets to take care of 345 cars; 287 in daily active service; 135 axle sets to take care of 265 cars; 149 in daily active service. Repair and maintenance costs for the axle-driven head-end sets are based on operating data of the Northern Pacific Railway.

Plan 2. Rental Plan A in which expense of installation of new apparatus is to be borne by supply company. Four hundred cars are to be equipped with generators of a uniform standard size and batteries, these cars being assigned to particular trains with 371 in daily active service. Balance of equipment (210 cars) to be lighted as at present, 65 in daily active service and 20 dynamo sets to be retained. The supply company bears expense of installation of the apparatus, charging facilities and their operation, and foreign freight charges on the apparatus. Lighting maintained by supply company at a fixed rate per car per month.

Plan 3. Rental Plan B similar to Plan A except that equipment becomes railroad property and railroad handles maintenance and shares in any saving effected. Cost based on set price per car per month. All generators of uniform capacity. Same assignment of cars as Plan 2.

Plan 4. Deferred Payment Plan A with deferred payments at a given amount per month for five years for equipment only with guarantee as to maximum maintenance material cost. All generators of uniform capacity. Same assignment of cars.

Plan 5. Deferred payment or purchase with payment spread over five-year period with interest on deferred payments at current rates. No guarantee of maintenance costs. All generators of uniform size. Same assignment of cars. Cost of purchase outright would be the same.

Plan 6. Outright Purchase Plan A with all generators of same capacity and same assignment of cars as plan No. 2.

Plan 7. All 610 cars equipped with proper capacity of generators and batteries. Outright purchase costs as in Plan 6 used. Present batteries used to extent available. Six hundred ten cars equipped with individual sets, 436 in daily active service.

Plan 8. All cars axle equipped except coaches and express cars; two cars may be lighted from one generator. All generators as under Plan 2 and 6. Same unit costs as in Plan 6. Four hundred sixty-five cars equipped with individual sets. Balance of cars available for lighting through train line. Same number in active daily service as above.

Plan 9. All cars axle equipped except that cars at head-end of train would be lighted from a single standard axle generator. All generators as in Plans 2, 6 and 8. Same unit costs as above. Four hundred one cars equipped with individual sets. Balance of cars available for lighting through train line. Same number in active daily service as above.

Plan 10. Same equipment as in Plan 9 supplied by Manufacturer X.

Plan 11. Same equipment as in Plan 9 supplied by Manufacturer Y.

All of the different plans considered were based on a selection, assignment, movement, mileage and connected lighting kw. hr. of the 610 cars as per study No. 2. This selection and assignment was drawn up after an extensive study had been made of the movements of all cars on the road. Study No. 1 takes into account all cars at present electrically-lighted, that is, represents the present system electric car lighting costs.

Basis of Determining Costs

Estimates of existing and new investment and fixed and operating charges were made for all of the various plans described above. These estimates provide a means of comparing the various plans as far as costs are concerned, but the relative values of lighting service obtained and other merits of the several plans need also to be considered. The estimates are not presumed to cover all of the schemes which it may be desirable to give thought to as the most satisfactory arrangements may not be among those shown.

The existing investment costs are derived from the original invested costs as shown in the valuation engineer's inventory of details supporting the "statement of original cost to date of passenger train cars" as reported to the Interstate Commerce Commission. On the basis of reproduction the costs would of course be higher. New investment costs are based on data worked up by this or other departments, and for new apparatus, on data secured from the manufacturers.

Fixed charges include interest taken at 6 per cent, depreciation at 1.75 per cent equivalent to a life of approximately 25 years with a small allowance for salvage value. Storage battery depreciation is taken as included in the maintenance costs. Taxes and insurance are taken as equivalent to 1.3 per cent on invested cost.

The investment cost involved in the use of baggage car space by the head-end sets was based on the conclusion that this use of space required the use of a 72-ft. car where, otherwise, a 60-ft. would do. The estimated cost correspondingly chargeable was taken at $700 per car per annum.

Of the operating charges the maintenance and repair costs are, as shown in the detailed descriptions of the various plans, derived from the records of the mechanical department, where applicable; otherwise, from such published or other data as was available.

The maintenance costs of individual equipments was built up from data gathered by the Association of Railway Electrical Engineers adjusted to present day costs.

The costs of energy, both for hauling and running the equipment, are important and were derived as follows: For hauling the equipment, and in the case of head-end sets, the extra weight due to the use of baggage car space, the fuel (or kw. hr. where electrically operated) required was based on that required to haul passenger equipment; in steam-operated territory, 158 lb. of coal per thousand gross ton miles including the locomotive.

For running the equipment, the additional coal rerequired to be burned in the locomotive, or the additional kw. hr. to be delivered to it was determined from the estimated lighting load. For steam-driven head-end sets an average figure of 105 lb. of steam per kw. hr. delivered was taken and 5 lb. of coal per lb. of steam. For axle-driven equipment a figure of 5.8 lb. of coal per horsepower hour at driver rim was used.

The same efficiency for several types of axle equipment was used. There is some difference in efficiency of the various types, but since the efficiency is dependent to a very large extent on the character of the service and other variable quantities, it is very difficult to arrive at a true efficiency without making some actual tests in service in which the equipment will be used. It was felt, however, that the assumption as to efficiency is satisfactory for the purpose.

No accurate data were available covering present costs of charging current nor as to what they might be under the changed conditions which most of the plans would involve. However, as this is relatively not a major item of expense, the lack of a satisfactory basis for estimate is not very important.

On the basis of determining costs as described above, each plan was considered individually and the total value and new investment costs tabulated are shown in Table I. The manner in which these figures were arrived at is shown for four plans in Tables II, III, IV and V.

Costs of the present lighting system were compiled on what it actually cost the railroad company during the period September, 1920, to March, 1922. The cost of maintaining the lighting equipment was taken from the monthly reports prepared by the mechanical department and based on data furnished by the Car Lighting Engineer.

Discussion

It appears feasible to light trains with a head-end axle generator system as referred to in Plan 1. The generator would be equipped with a regulator which would maintain the desired voltage on the train line at all generating speeds and regulators would be provided on each car equipped with a storage battery. The remaining cars would be lighted by train line from the battery cars. However, the size of the present train line would have to be increased. It would not be desirable to attempt to light every train through such a system as certain of the trains could be more economically lighted from individual axle generators, and it is on this basis that the cost of the head-end arrangement has been estimated. Operation of the head-end axle equipment has been successful on other roads but experience has shown that maintenance costs for the generator and the generator drive are comparatively high. Investment costs are based on quotations received from manufacturers. It is felt that while the costs developed are, owing to the high apparatus prices, greater than might actually obtain, they cannot be sufficiently reduced to overbalance the operating advantages possessed by the individual axle generator system. It is, moreover, to the interest of the railway company to adopt a system which is becoming more and more standard with other roads, rather than to experiment with a comparatively untried type of equipment.

Plans Nos. 2 and 3 are desirable arrangements in respect to the facts that the railway company would be assured of satisfactory lighting and would be relieved of the major part of the investment costs and would be relieved also of a proportionate amount of the supervisory work involved. In opposition to these points are the facts that the unusual investment involved in the purchase of new equipment could be lessened either through buy-

ing on some deferred payment plan or by acquiring new equipment gradually, that the company with its own organization should be as able to secure satisfactory lighting as an outside company, and that such lighting could be secured at a considerably lower cost than that which would be incurred under any rental scheme proposed.

The Deferred Payment Plan, No. 4, provides a way of decreasing the unusual cost, but the cost of apparatus with such a plan should not be made much, if any, more than the outright purchase plan, plus interest.

Plan No. 5 is the one mentioned above whereby the equipment is purchased at regular prices with payment made therefor in monthly or yearly installments, with interest. The cost is the same if the equipment is purchased outright. The estimate is included for purpose of comparison.

Plan No. 6 consists of an estimate provided for comparison with Plan No. 2, that is, the railway company purchasing and maintaining apparatus as against the same lighting being maintained by the manufacturer. It should be noted that this and the previous four estimates are on the basis of applying axle generators to 400 cars used in certain specified trains. This basis was used in order to secure a suitable comparison. However, any plan to equip only certain specified trains with 32-volt axle equipments, as contemplated in this and the previous four estimates, retaining the rest of the trains as they are, does not appear to be economical. The direct operating costs of such an arrangement would be higher, and the difficulties which would be experienced with about half of the cars with axle equipment at 32 volts and the remainder with head-end equipment at 64 volts would bring about indirect costs which, although difficult to estimate, must be borne in mind.

Plan No. 7 is an estimate of the costs for the case where all of the 610 cars of the study are equipped with axle generators, and battery capacities to conform to the best present practice for the various types of cars. This cost is, of course, more than the cost where 400 cars in specified trains are equipped. The results as to the lighting would, of course, be much superior and the operating conditions improved. The assignment of cars by the transportation department, in as far as the 610 cars are concerned, would not be limited by the lighting equipment.

In the scheme presented in Plan No. 8 it is assumed that certain cars would not have axle generators, but these would be such cars that with the usual make-up of trains, not more than one car would be lighted from an adjacent generator-equipped car. All tourist, sleepers, parlor cars, etc., would have generators. There is a decided decrease in the cost with this arrangement over that with every car equipped, since but 465 axle equipments are required instead of 610.

Plan No. 9 assumes that there be installed individual axle generators on all cars normally operated back of the coaches and also on all full postoffice cars, but that the remainder of the head-end cars be lighted by a train line from a single unit located under the baggage car. It was thought desirable to have generators for most of the full postoffice cars on account of the importance of that service. With this arrangement the lighting could be taken care of by about 400 axle sets. Lighting more than one car from one axle generator introduces the necessity of attention in the assignment of cars only to the extent of making sure there is a generator-equipped baggage car among the head-end cars and that the number of cars to be lighted from this generator does not exceed the capacity of the generator. Overloading the generator would occur only in exceptional cases, as four or five cars of the classes involved can readily be lighted from one axle generator using one of the various sizes now standardized. Putting up train connectors should present no difficulty and would be taken care of by the regular train crew. The feature which would probably be of the greatest objection would be that in case a coach or other car were detached from the train for any purpose as in switching at stations the coach would be without lights since only the generator car would be equipped with a storage battery. It would be possible to add storage batteries and regulators to such cars without applying a generator, and this would be an intermediate arrangement between the one just described and the one wherein a generator would be used on such cars, but since the greater part of the cost of the operation pertains to the batteries, such an arrangement was not figured on, as the saving obtained would not seem to warrant the omission of the generator.

In laying out a tentative car assignment as a basis for the estimate on this plan, it appears practical to select cars in such a manner as to insure that each train would have its proper quota of equipped cars without necessitating a great deal of selection by the transportation department. Equipping all cars with individual generators of course gives the greatest freedom of selection of cars, and this is the method used by many roads having axle equipment, but the increased cost does not appear to be warranted. It should be noted that in speaking of all cars, 610 equipments are referred to. The remaining cars on the system would be lighted by headlight generators, etc., as at present. The determination of the number of head-end cars which should be equipped should depend in part on the degree of difficulty which the transportation department might have in obtaining suitably equipped cars to make up their electrically lighted trains. From an engineering standpoint, the use of the minimum number of equipments mentioned above is practicable and it appears equally practicable in considering the operating figures.

In the case of Plans 10 and 11 it should be noted that in all cases the same maintenance costs are assumed for all makes of equipment.

Conclusions

In the development of this study along the lines followed it is the opinion of the authors of the report that in order to be in a position to decide intelligently on further procedure, it would be necessary to study carefully the difficulties with the existing system and the reasons therefor, to determine what other systems were available and the extent to which their use would remedy the difficulties, how to determine what the costs of such improved methods would be as compared with present costs.

The cost estimates show that Plans 9, 10 and 11 which eliminate the present steam generating sets and provide for all cars considered to be lighted from axle generators and storage batteries of one standard size, but train lining certain cars not equipped with axle generators to others

equipped with axle generators are the most economical. Of course, at any time as found necessary, additional axle generators can be installed on the cars which initially would be merely train lined. The plans do not possess the flexibility of Plan 7, inasmuch as a certain amount of selection of equipment by the transportation department is necessary to insure that an axle equipment feeding more than one car will not be overloaded. With Plan No. 7 this selection is not necessary as all cars are assumed to be provided with axle generators, the size of these respective axle generators corresponding to the load requirements of the respective cars under which they are installed. The authors believe, however, that Plans 9, 10 and 11 should not involve any particular difficulty as far as the selection referred to is concerned. These plans, as previously described, are on the basis of purchase of the apparatus outright since rental plans as submitted provide, except in case of emergency, that the only load on any individual axle generator shall be that of the particular car on which such axle generator is installed. It is assumed the main objection which will be found to these plans, as compared to the actual plans, is the high initial investment, but it must be remembered that the yearly costs are higher with the latter.

In order to secure the benefits of reduced operating costs and improved lighting without too great an initial outlay, a desirable compromise might be to follow gradually along lines ultimately leading to Plans 9, 10 and 11, individual axle generators to be applied initially only to certain types of cars, selected firstly, as to give improved lighting to cars which require it most or which are most important, and secondly, as to relieve those trains where the lighting load is heavy. This would not only give good lighting to the cars which most need it, but by relieving the load on the generating system would improve the lighting of the other cars. The application of the equipment being made progressively, it would be necessary to make some temporary provision whereby the 32-volt lamps on the axle equipped cars would not be thrown directly on the 64-volt train line. This could be accomplished by blocking certain of the lighting switches or other simple temporary arrangement.

TABLE NO. I

Summary of Estimated Costs of Electric Car Lighting

		New Investment	*Yearly Cost*
Study No. 1	Past costs, all cars........		$331,920
Study No. 2	Past costs of 610 cars.....		299,770
Plan No. 1	Improved head-end equipment plus 135 axle sets..	$706,850	330,910
Plan No. 2	Rental Plan A 400 axle, remainder as at present	37,110	350,425
Plan No. 3	Rental Plan B 400 axle, remainder as at present	37,136	345,220
Plan No. 4	Deferred Payment (after 4th year) 400 axle, remainder as at present	774,370	347,600
Plan No. 5	Deferred payment or purchase 400 axle, remainder as at present	552,070	341,790
Plan No. 6	Purchase Plan 400 axle, remainder as at present	623,570	343,820
Plan No. 7	All cars axle equipped ..	650,600	335,450
Plan No. 8	Axle equipment, more cars train lined	541,900	297,300
Plan No. 9	Axle equipment, more cars train lined	438,840	261,680
Plan No. 10	Same as Plan 9 Manufacturer X	398,780	257,980
Plan No. 11	Same as Plan 9 Manufacturer Y........	390,900	249,780

TABLE NO. II

Study No. 1—Present System: Excl. business cars and axle-lighted cars and motor cars
Excl. item not affected by purpose of study
Excl. charging facilities

Investment:		
Generating sets and switchboards..........	$112,900	
Storage batteries 205 at $544..............	111,600	
Battery boxes 361 at $100	36,100	
Wiring, fixtures, accessories, etc. $\frac{1022}{978} \times 207,320$	216,500	
Baggage car space $65 \times 10,000 \times .07$.......	47,600	$524,700
Fixed Charges:		
Inte. (6%), taxes and insurance (1.30%), depr. (1.75%) $= 0.905 \times 524,700$........		$47,500
Maintenance & Repairs:		
Generating sets	$32,650	
Batteries $\frac{205}{230} \times 31,452 =$	28,000	
Battery boxes $.05 \times 36,100 \times 2$	3,520	
Lamp renewals $\frac{979}{980} \times 12,348 =$	12,340	
Wiring, fixtures, accessories, etc. $\frac{979}{980} \times 24,280 \times 2$	48,550	
Steam hose	7,790	132,960
Attendance dynamo cars..................		26,450
Energy:		
To run sets, steam turbines................	46,100	
To run sets, electric trolley................	2,040	
To haul sets and batteries..................	34,430	
To haul portion of baggage car............	13,350	
Charging current	16,850	112,770
Supervision		12,240
Total fixed and operating charges........		$331,920

TABLE NO. III

Plan:
No. 1—Chain-driven, head-end sets

Investment				*Present Inv.*	*New Inv.*
Head-end sets	37	at	$6,213		$229,900
Car regulators	295	at	306		90,250
Individual axle sets	135	at	880		118,800
Batteries	295	at	620		182,900
	135	at	544	$73,440	
Susp. frames and truck changes	135	at	71		9,580
Regulator cabinets	(430-253)	at	14		2,340
Battery boxes	346	at	100	34,600	
	84	at	215		18,080
Wiring, fixtures and accessories	(610-151)	at	120	136,400	55,000
Baggage car space	37 x 10,000 x .07			25,900	
				$270,340	$706,850
Salvage present generating sets and switchboards:—					
Valuation value					$109,500
Accrued depr. assumed for 15 yr. at 1.75%, 6% basis					44,600
					$64,900
Salvage value at $200 per set					13,200
Amt. of loss (on which int. continues) ..					$51,700
Salvage present batteries abandoned					
Valuation values 55 at $544					$29,920
Accrued depr. assumed for 15 yr. at 1.75% (.42)					12,500
					$17,420

Salvage value at $532		34,760
Amount of gain		$17,340
Net loss sets and batteries		34,360
Fixed Charges:—		
Int., taxes, ins., & depr. 9.05% of 977,190	$88,440	
Int. 6% on 34,360	2,060	$90,500
Maintenance & Repairs:—		
Chain-driven head-end generators	$40,000	
Head-end lighted cars	83,180	
Axle lighted cars 3.14 × 10,280	32,300	$155,480
Energy:—		
To run sets	$21,520	
To haul equipment	41,200	
To haul space in baggage car	8,860	
Charging current	2,600	$74,180
		10,750
Supervision:—		
Total fixed and operating charges		$330,910

TABLE NO. IV

Plan No. 7. All cars axle equipped

First Costs:—	*Present Inv.*	*New Inv.*
Generators	See below	$500,000
Batteries	$103,300	89,660
Susp. frames and truck changes		43,310
Regulators cabinets		5,000
Battery boxes	34,600	3,170
Changes in fans		4,660
Wiring, fixtures and accessories	136,400	
	$274,300	$650,600
Salvage present generating sets and switchboards:—		
Valuation value		$109,500
Accrued depreciation assumed for 15 yr. at 1.75 per cent, 6 per cent basis		44,600
		$64,900
Salvage value at $200 per set		13,200
Amt. of loss (on which int. must continue to be paid)		$51,700
Fixed Charges:—		
Int. (6%) taxes and insurance (1.3%) depr. (1.75%) 9.05% of $924,900	$83,700	
Int. 6% on $51,700	3,100	$86,800
Maintenance and Repairs:—		
610 cars at 22.30 per mo. = $163,300 or using mileage basis we would have 59,780 M. car mi. at $3.14		$187,700
Energy:—		
To run sets	$20,330	
To haul sets and batteries	38,018	
Charging current	2,600	60,950
Supervision (incl. maint. & repr.)		
Total fixed and operating charges		$330,650

TABLE NO. V

Plan No. 9.
Axle equipment, with most of the head-end cars train lined.

First Costs:—	*Present Inv.*	*New Inv.*
Axle generators		$400,000
Batteries	$103,300	12,100
Susp. frames and truck charges		28,550
Regulator cabinets		2,070
Battery boxes	34,600	660
Changes in fans		4,060
Wiring, fixtures and accessories	136,400	
	$274,300	$438,840
Less present generating sets and switchboards as for No. 7		$51,700
Fixed Charges:—		
Int. (6%) taxes and insur. (1.3%) depr. (1.75%) or 9.05% of $713,140	$64,500	
Int. 6% of $51,700	3,100	$67,600
Maintenance and Repairs:—		
401 axle cars at $3.14 per M. Mi	$123,500	
209 cars train lined:—		
Lamp renewals 26.9% of $12,336	3,320	
Wiring, fixtures, accessories, etc. 23.7% of $48,548	11,500	$138,320
Energy:—		
To run sets	$20,330	
To haul sets and batteries	31,450	
Charging current	2,600	54,380
Supervision not included in axle lighting 11.3% of $12,240		1,380
Total fixed and operating charges		$270,880

Radio Equipment on L. & N. Trains

During the past two months the Louisville & Nashville has been operating improved service between Cincinnati, Ohio, and New Orleans, La., on its all-Pullman, Pan-American trains. Among other things and one which is of greatest interest to the average electrical man is the radio equipment which has been installed on these trains.

The permanent installation of radio-receiving equipment on the new train is the result of exhaustive tests by the Louisville & Nashville covering a period of many months. In considering this question, the railroad also had the benefit of tests made some years ago along similar lines, and was familiar with the difficulties to be expected

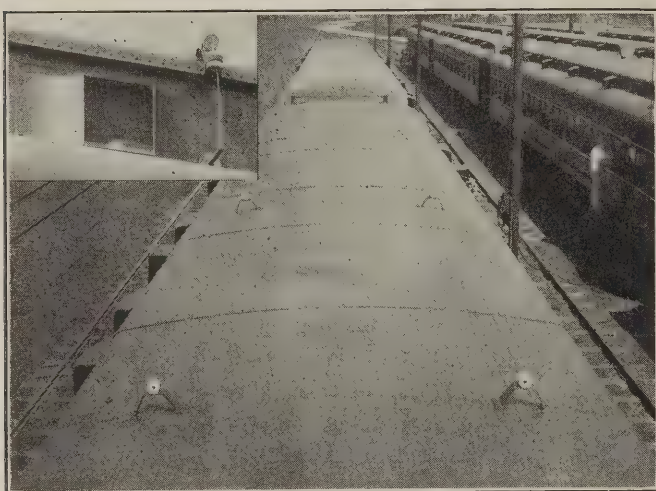
View Showing the Decoration in the Parlor-Observation Car and the Individual Radio Head Phone Equipment

in attempting radio reception under the peculiarly adverse conditions encountered in this service.

It was early recognized that because the radio set is installed on the inside of a steel car, special arrangements were necessary to overcome the shielding effect of the metal envelope. At the same time, it was recognized that on account of tunnel clearances, it would not be practicable to erect an aerial on top of the car which would be of sufficient height above the steel roof to eliminate altogether the capacity of the aerial to the ground, and that the set proper would have to strike a medium between ultra and low sensitiveness, to avoid the natural interference from signal wires, paralleling high tension circuits, static disturbances generated by revolving wheels on steel rails, and the serious interference from the generators used on cars

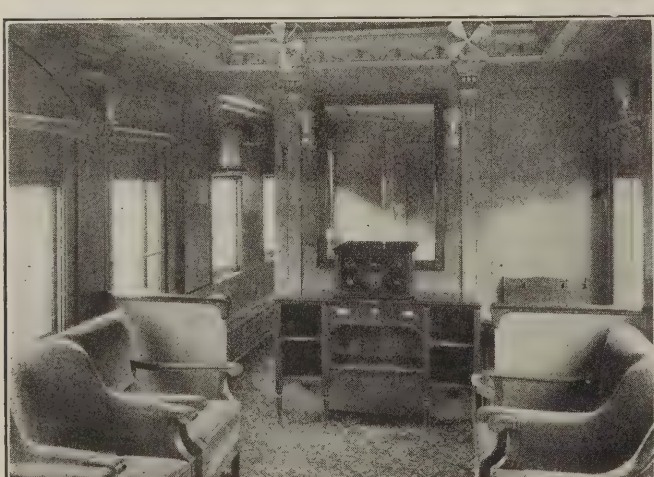
for charging storage batteries used in lighting service.

Aside from these difficulties, it was also shown by previous tests that an aerial must be provided with a non-directional effect, as otherwise signals would fade when the car passed around the numerous curves on the average railroad, and the aerial itself must in no sense be shielded by the dome of the car roof. The selection of a final aerial was based on actual tests of numerous types,



Radio Aerial of No. 8 Gage Stranded Wire Extends Once Around the Car Roof Dome—The Insert Shows the Aerial Entering the Car

and it was found that a single wire, No. 8 gage stranded, strung entirely around the dome of the roof, and clearing this dome four inches, was about the most efficient that could be secured, the aerial being tapped and run to the interior of the car with insulated wire of a little smaller gage. After this had been determined, came the question of selecting the type of instrument to be installed, and this required exhaustive investigation in actual running serv-



Uni-Control, Five-Tube Radio Receiving Set in the Parlor-Observation Car

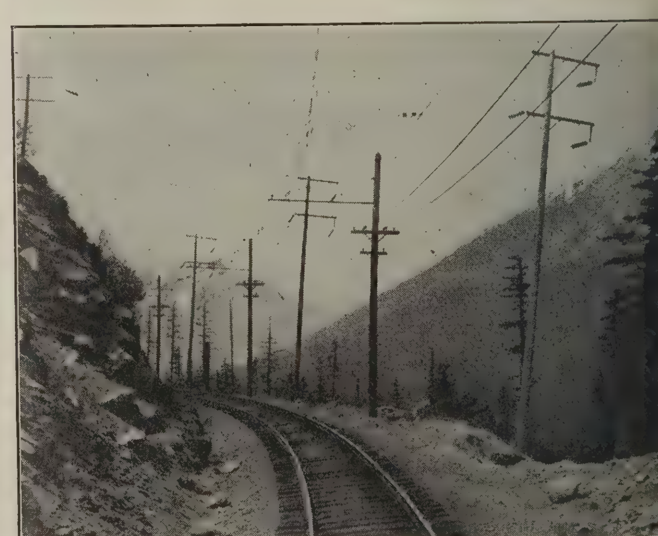
ice. No attempt was made to test miscellaneous equipments advertised on the market, but the active radio principles as known at the present time, such as Heterodyne, Neutrodyne, Radio Frequency, Reflex and Regenerative were represented by a number of sets operating on each of these principles. This, of course, brought the manufacturers of such sets into active competition on notification by the railroad that the tests were being conducted. The manufacturers were asked to furnish sets and to have their own representatives operate such sets on an actual train movement. This request was complied with by the most representative concerns in the country and a steel coach was fitted up with antenna and the sets placed on seats in the car, being so arranged that each set would tune in on the same signals, one after another. The car was then equipped with head receivers in multiple placed in the opposite end of the car, a sufficient distance away from the sets so that the observers would be unprejudiced in their comments, not knowing at the time of reception what particular type or manufacture of set was being operated.

As a secondary precaution against bias or prejudice, representatives of other departments than that making the test were selected to pass upon the practicability and utility of the service and to report direct to the heads of their own departments.

After this arrangement had been completed, the coach was taken on the road and given a series of runs, with the result that the test became a contest of elimination of sets, simmering rapidly down by consent of the manufacturers themselves as the trial progressed. The net result was that after a few trips had been made only a small number of sets were left.

The question then became one of operation, and it was decided that the best proposition would be to install apparatus as simple in tuning as possible and allow the sets to be handled by the passengers, with certain instructions as to hours when service could be expected, and supervision of the installation at terminals. At the present time, the set installed is a uni-control proposition, five-tube radio frequency, which was found to be efficient when the aerial was energized by incoming signals of even moderate strength while on the run. It is not expected to attempt any daylight reception except after four o'clock in the afternoon.

Seeking the right destination for improperly addressed mail is a source of considerable expense to the government. Last year the handling of this class of mail matter cost about $1,740,000.



Along the Western Slope of the Cascades in Washington on the Electrified Section of the St. Paul

Important Relation Between Light and Vision*

Money Spent for Improved Lighting May Often Bring Large Increase in Production Output

GOOD artificial illumination is a development of comparatively recent years, and although it is quite generally conceded to be desirable, there are few who entirely comprehend how the accompanying benefits are derived. The following curves present basic facts which provide a direct link between light and time—between better illumination and the increased production and decreased accidents, which have invariably resulted.

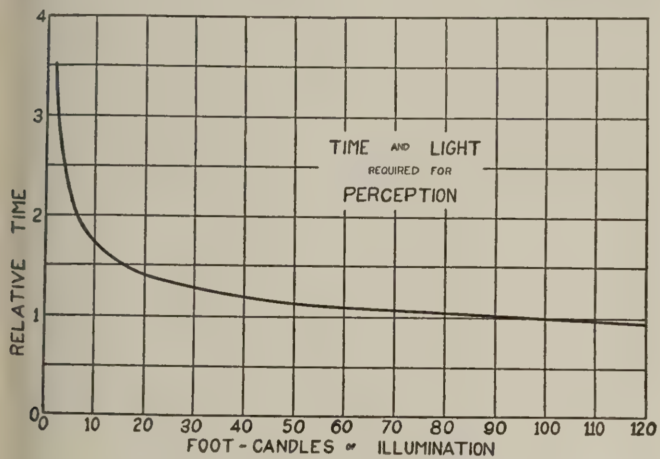


Fig. 1—To Perceive the Mere Presence of a Black Dot on a White Background, It Will Be Noted That the Eye Requires 3½ Times As Long Under 2 Foot-Candles as Under 100 Foot-Candles

In addition, good lighting has numerous other advantages which cannot be expressed numerically, but which are none the less real and important. The marked improvment made in the general appearance of a room, the cozy comfortable atmosphere created in the home, the stimulating enlivening influence exerted in the store, the office and the shop—these are valuable by-products of proper illumination.

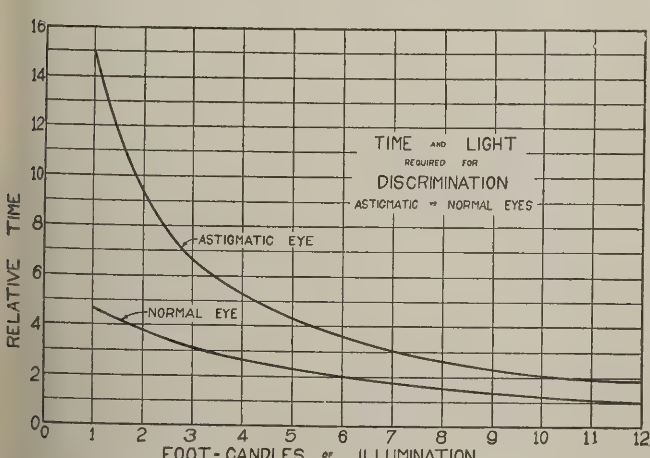


Fig. 2—Higher Illumination Decreases the Time Required for Vision and Lessens the Handicap of Astigmatism

* An abstract from a booklet entitled "Light and Vision," published by National Lamp Works, Nela Park, Cleveland, O.

Perception

Fig. 1 shows the relation between the level of illumination and the simplest visual operation—perception. This curve illustrates the outcome of a series of tests in which a black dot was exposed momentarily on a white field, and for each level of illumination the shortest exposure was found for which the subjects could detect the mere presence of the dot. The curve shows that at 2 or 3 foot-candles, which is a common value of artificial interior illumination, a relatively long time is required for perception. With an illumination of 10 to 20 foot-candles, which now represents very good practice, the time required for perception is much less, and it decreases steadily as the illumination is raised still further. This is to be expected, since the range of outdoor illumination to which the eye has become accustomed through centuries of evolution is usually from 100 foot-candles, which corresponds to the waning illumination at sunset, to 10,000 foot-candles on a bright summer day.

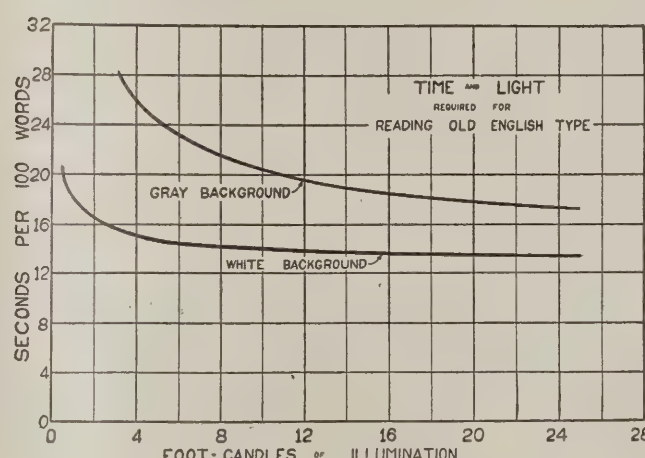


Fig. 3—The Time Required For Reading Decreases as the Illumination Is Raised and Is Less With a Sharp Contrast Between Type and Paper

Discrimination

Good vision requires more than the mere perception of an object; it requires the discrimination of its fine details as well. The speed with which this discrimination can be accomplished—or in other words, the speed of vision—involves all factors of light and lighting which influence the ability of the eye to distinguish details by differences in brightness and color. Tests similar in character to the "perception" tests, have been conducted on the relation between the time required for discrimination and the amount of illumination. The results show the same general trend as that noted in the curve of Fig. 1; the eye discriminates details more rapidly under the higher levels of illumination, although requiring more time than for mere perception.

In all these basic tests it should be remembered that if the contrast between the test objects and their back-

grounds were less pronounced than black on white a much higher illumination would be required to give the same clearness and quickness of vision.

The Astigmatic Eye

Further tests have proved that an astigmatic eye always requires longer for discrimination—for vision—than

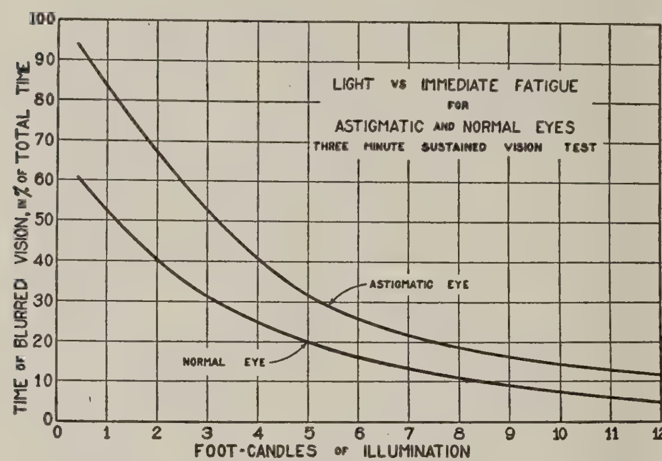


Fig. 4—Raising the Illumination Reduces Eye Fatigue, as Measured by Less Blurring of Sustained Vision

does a normal eye under the same illumination. The curves in Fig. 2, covering the more common intensities of artificial lighting, show this to be the case. They also show that an increase in illumination benefits the astigmatic eye to a relatively greater extent than the normal eye, or conversely, at the lower levels of illumination the astigmatic eye is handicapped even more than the normal eye. This fact is especially worthy of note, because more than half of the industrial workers of today have defective vision.

Reading Test

The practical value of these results has been verified by a test on the speed of reading, shown in Fig. 3. As would be expected, the time required to read 100 words becomes appreciably less as the illumination is raised. It will also be noted that reading was faster with a sharp contrast between the type and its background. This latter fact is significant, since in the everyday uses of the eye, with the single exception of the printed page, brightness contrasts are seldom found as pronounced as black on white, which is the best condition for clear vision.

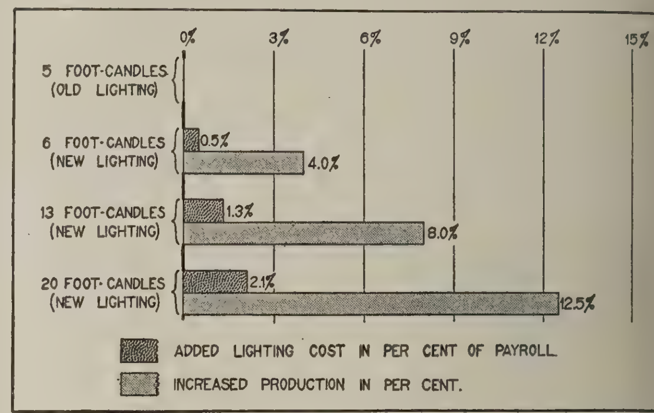


Fig. 5—The Increased Production Far Exceeds the Added Lighting Costs

Eye Fatigue

It is a common experience that under a continuous gaze the eye becomes fatigued to such an extent that the details of the object viewed become blurred part of the time. Fig. 4 shows the results of tests which have established the fact that under low illumination a fixed gaze fatigues the eye rapidly, whereas raising the illumina-

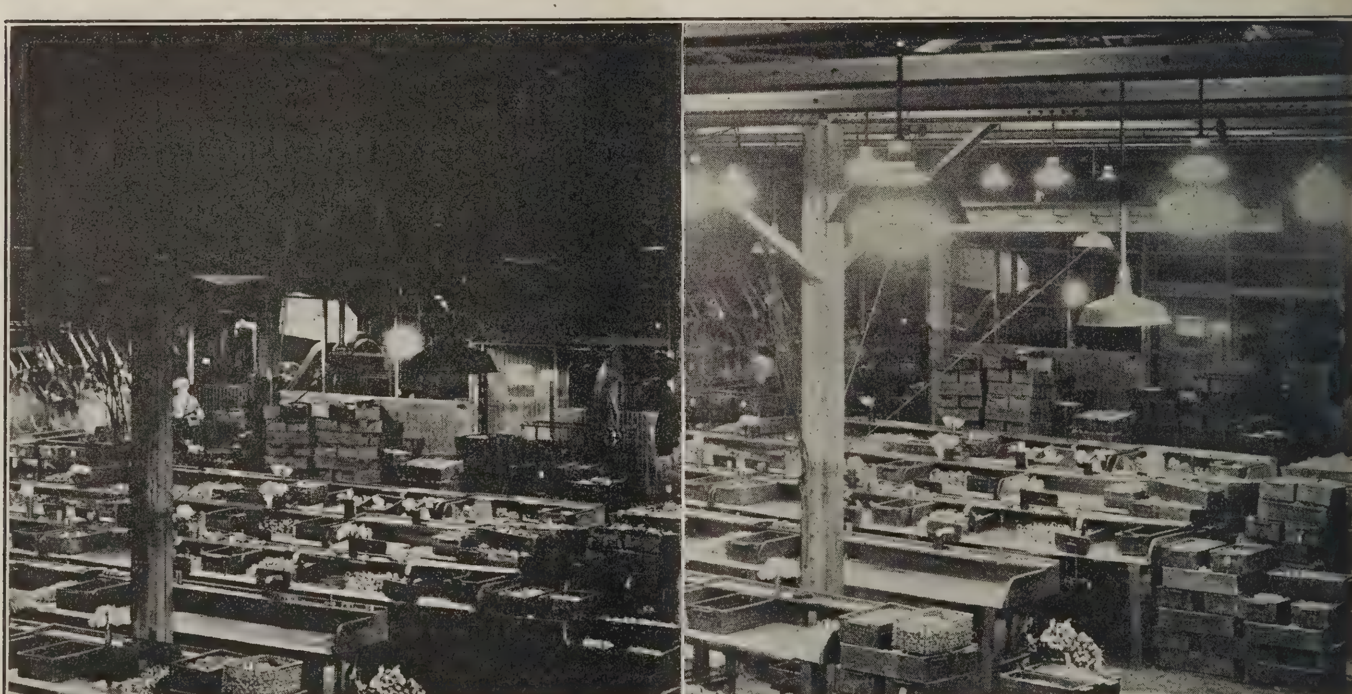


Fig. 6—Old and New Lighting Systems, Under Which the Effect of Illumination on Production Was Tested

tion improves the clearness of sustained vision to a considerable extent. Here again the astigmatic eye is handicapped even more than the normal eye by insufficint illumination.

Glare and Vision

The foregoing tests have demonstrated rather conclusively that by increasing the quantity of light the speed and accuracy of vision are increased. This is only true, however, where the eyes are not subjected to glare. It is generally known that the pupil—the gateway of vision—contracts very much when the eye is exposed to glaring

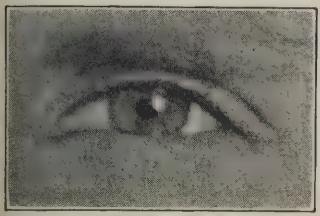


Fig. 7

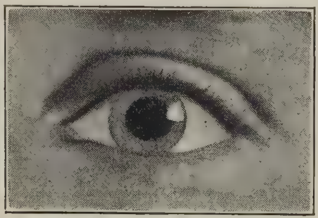


Fig. 8

Fig. 7—Pupil Contracted By a Glaring Light Source as in Fig. 9
Fig. 8—Pupil Expanded Under Proper Lighting as in Fig. 10

light sources, but the practical effect of this contraction, which is Nature's safety valve, is usually overlooked.

When one looks at an object, an image of the object is formed within the eye, and nerves transmit the picture to the brain. The fundamental factor in vision is the brightness of this image, which is proportional to the area of the pupil and to the brightness of the object viewed. In the absence of glare the pupil automatically expands, which is equivalent to increasing the illumination on the object viewed.

To illustrate this point, suppose a workman has 10 foot-candles upon his work, but the lighting is so glaring that his pupils are contracted to a diameter of ⅛ inch. A second workman also has 10 foot-candles upon his work, but the lighting units are of proper design and are hung well out of his direct line of vision, so that the absence of glare allows his pupils to expand to 3/16 inch. The brightness of the image within the eye being proportional to the square of the diameter of the pupil, the images of the second workman will be about twice as bright as those of the first workman. Even though the intensity of illumination at the work is exactly the same in the two cases, the second workman is really enjoying the advantage of twice as much "seeing" light. His visual doorway is open a hundred per cent more than that of the first workman exposed to glare. There are other beneficial results arising from elimination of glare, such as greater comfort and safety, but the one just stated is directly measurable in terms of foot-candles.

Fig. 9—Bad Practice—A Glaring Local Light Causes Poor Vision, Eye Strain, Fatigue, and Danger of Injury

Illumination and Production

These studies of the fundamentals of light and vision have a very practical value in pointing the way toward increased productiveness in industry, and in other fields. Tests have been run in a number of industrial plants to determine the relation between illumination and production, other factors being kept constant. In every case, increasing the illumination has increased the production far beyond the added lighting cost.

One such investigation was completed not long ago in the inspection department of the Timken Roller Bearing Company at Columbus, Ohio. The number of bearings inspected per operator per hour was found, first under the old lighting system providing an average of about 5 foot-candles on the work, and then under well-designed systems providing 6, 13, and 20 foot-candles. Unusual care was taken to prevent any factors other than illumination from influencing the results. During the ten weeks of the test the humidity and the interior temperature were kept practically constant, and the employees did not know their production was being investigated.

Fig. 10—Good Practice—Uniform Well Diffused Illumination Results in Good Vision, Comfort and Safety

The results of the test furnish proof that for the class of work carried on in the department investigated the production is materially affected by the illumination supplied. Without exception, the production increased when the illumination was raised, and decreased when it was lowered.

Under the old glaring lights, which gave only about 5 foot-candles on the work, the number of pieces inspected per operator per hour was 408. Under a well designed system providing 6 foot-candles, with a minimum of glare and objectionable specular reflection, the number of pieces inspected per operator per hour was 424, repre-

senting a 4 per cent production increase over that obtained under the former faulty illumination of about the same foot-candles. Likewise, increasing the illumination from 6 to 13 foot-candles with a well designed system resulted in an output of 440 pieces per operator per hour, representing a further 4 per cent production increase, and when the illumination was raised to 20 foot-candles, the production increased to 458 pieces per operator per hour, which was an additional 4.5 per cent increase. Thus, comparing the 20 foot-candle system with the one originally in use, a 12.5 per cent increase in production is found.

Economics

Fig. 5 shows the production increases obtained by raising the illumination, as compared with the added cost of the better lighting.

The cost figures for the Timken installation are:

Cost of lighting (current, lamp renewals, fixed charges, etc.) new 20 foot-candle installation	$ 0.32	per hour
Cost of lighting, old 5 foot-candle installation...	$ 0.04	" "
Added cost of better lighting..................	$ 0.28	" "
Hourly total wages of 44 inspectors............	$13.20	" "
Hourly saving through a 12½ per cent production increase	$ 1.47	" "

Thus the saving to the company is over five times the added cost of the better lighting.

Illumination in Other Fields

Though the foregoing tests on the fundamentals of light and vision have been here linked with production in the industrial field, clearly they have the same significant bearing on the efficiency of all other kinds of work. Consequently, best results in offices, schools, drafting rooms, etc., can be obtained only where the deficiencies of daylight are met by adequate artificial illumination.

In addition to assisting the worker, good lighting has powerful beneficial influences in other phases of everyday life. In the commercial field, the attracting power of the brightly-lighted show window has been demonstrated repeatedly, and within the store good illumination not only assists the customers in selecting the merchandise wanted, but its cheerful atmosphere builds good will and stimulates the desire to buy.

Insufficient illumination is the direct cause of over 17 per cent of the night traffic accidents. Adequate street lighting avoids this loss, besides decreasing crime, facilitating traffic movement, and generally arousing civic pride.

To assist the 30 per cent of the school children who have defective vision, and to prevent astigmatism caused by eye-strain, the school and the home should have ample light.

Head-End Lighting Branch Line Trains

The Northern Pacific has recently equipped eleven locomotives with 7½ kw. Pyle-National turbo-generator sets for the lighting of branch line trains. Three of the locomotives are used on trains running between Centralia, Wash., and South Bend, Wash., the run consisting of a round trip of 116 miles, four are used on trains running between Seattle, Wash., and Moclips, Wash., a 163-mile run, and four are used on trains running between Spokane, Wash., and Lewiston, Idaho, a distance of 146 miles.

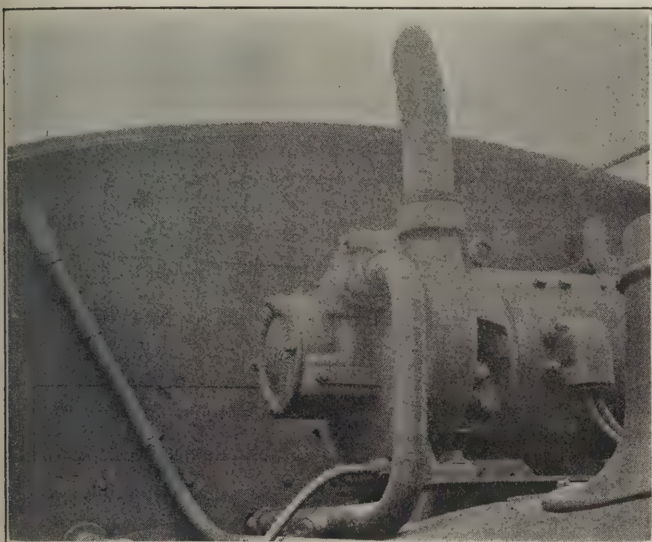
The trains generally include three or four cars, but at times it is necessary to haul more. The lighting load in each car is about 1000 watts and on occasions as many as eight cars have been used on a train. The cars are each equipped with a three-wire train line. No batteries are used.

The turbo-generator is mounted on top of the locomotive boiler just in front of the cab. It is not at all conspicuous as its over-all dimensions are, length, 38⅜ in.; height, 18⅞ in.; width, 20⅝ in. The generator is a four-pole machine with a normal speed of 3400 revolutions per minute. It is so designed as to furnish 7 kw. at 64 volts d. c. for lighting the cars in the train, and in order to provide current for the locomotive lighting at the standard 32 volts, collector rings have been added to the armature. The design of the machine is such that even though the machine is over-compounded on the direct current side to take care of voltage drop in the train line as more cars are added, the a. c. voltage at the collector rings does not deviate appreciably from 32.

The wiring for this type of lighting is extremely simple. The locomotive wiring for headlight and cab lights is not changed. The 64-volt circuit is run in rigid metal conduit from the generator into the cab to a Urelite circuit breaker mounted on the cab ceiling. From the circuit breaker it is run to a point at the rear of the cab roof ex-

The 7½ Kw. Train Lighting Turbo-Generator Is No More Conspicuous Than the Ordinary Headlight Set As Installed on the Branch Line Locomotives

tension on the right hand side, where the conduit is fitted with a condulet and the wire is run open to another condulet and conduit run mounted on the right hand side of the tender tank. This run leads to a Gibbs connector mounted at the center on the back of the tank. It is elevated a little above the tank so that it is at the same height as the corresponding connector on the first car.



The Set Is Mounted on Top of the Boiler Just in Front of the Cab

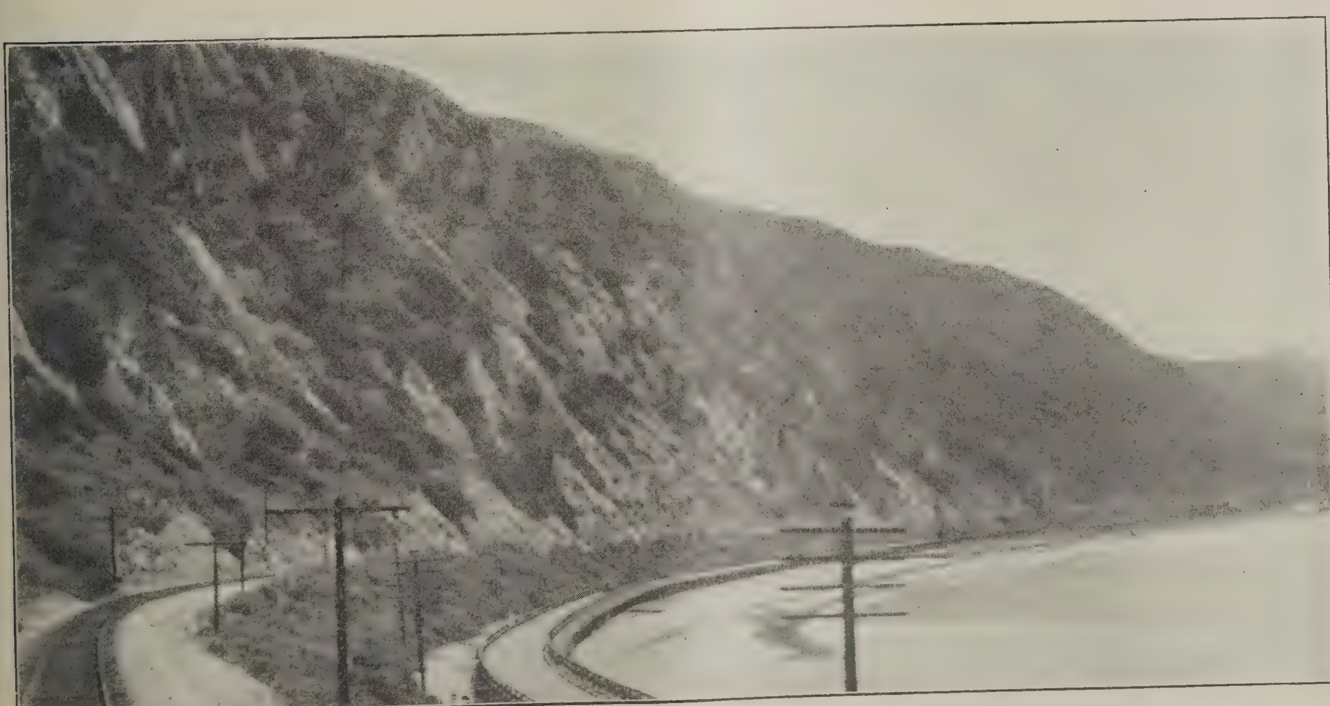
The connector on the tank is protected from the weather by a sheet metal housing.

It sometimes happens that a car equipped with a battery is switched into one of the trains and to provide for this emergency a 15-watt, 64-volt pilot lamp is mounted on the ceiling of the cab, back of the circuit breaker. This lamp is connected to the terminals of the circuit breaker on the train side. When a car with the battery is switched into the train and the connectors put up, the train line will be made live by the battery provided the battery switch is closed. This fact will be evident to the enginemen as the pilot lamp will burn. If the pilot lamp burns the engineman will not close the circuit breaker in the cab until the battery switch on the car has been opened.

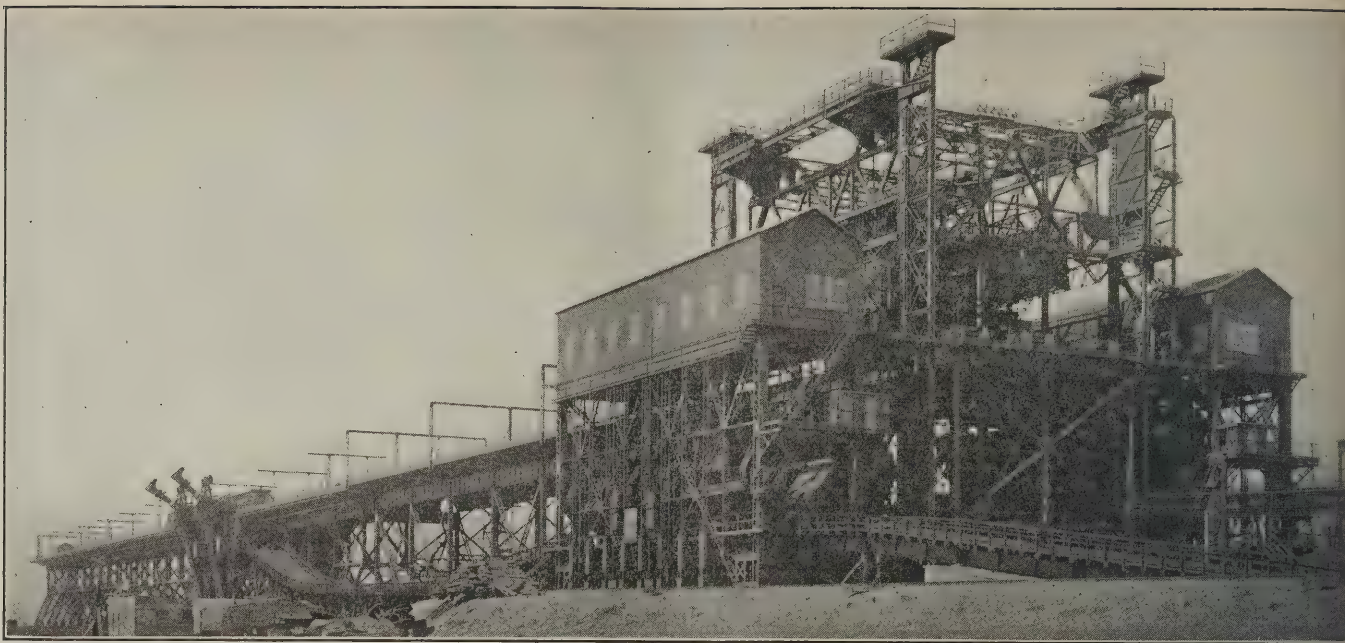
The pilot lamp also serves to indicate whether or not the circuit breaker is closed. When the breakers were first applied, the jar of the locomotive would occasionally be sufficient to cause the tripping arm to strike the operating mechanism and trip the breaker. The difficulty was very easily overcome by attaching a light spring to the tripping arm.

The enginemen who operate the sets are well pleased with their performance and declare they do not use any more steam than an ordinary headlight set. Actually the no load water rate is 200 lb. per hour and is 810 lb. per hour at the full load of 7½ kw. Cost of maintaining the sets has been extremely low.

The favorable balance in France's export trade in electrical goods noted during the first half of 1924 was maintained throughout the whole year and shows indications of continuing. Reports show that the excess of exports over imports for the whole of last year amounted in value to 328,315,000 francs. France's electrical exports for 1924 exceeded those of 1923 by 141,659,000 francs. Electrical machinery and transformers account for more than half the value and weight of the exports and about one-third of the value and weight of the imports. The most important articles imported were electric lamps with metallic filaments, to the value of nearly 44 million francs, while the exports and re-exports of these lamps amounted to nearly 30 million francs. Electric wires and cables to the value of 52 million francs were exported, imports of these articles amounting only to 3½ millions.



A Section of the Southern Pacific Along the Coast Between Los Angeles and San Francisco



The Sewall's Point Coal Pier of the Virginian Railway

New Coal Terminal of the Virginian Railway

Huge Pier, Electrically Equipped, Is Capable of Handling Enormous Tonnage in Record Time

By Cecil Gray
Westinghouse Electric & Manufacturing Company

THE electrification of the Virginian, consisting of 134 route miles from Mullens, W. Va., to Roanoke, Va., has aroused the interest of railroad officers and engineers throughout the country, and has again shown the progressiveness of the management of this road in thus preparing for a considerably increased tonnage in the future. This electrification is interesting first on account of the magnitude of the undertaking and also on account of the choice of a system practically identical with that of their neighbor, the Norfolk & Western Railroad, after the experience of the latter road during a period of about eight years.

Prior to the present undertaking, the Virginian had established a reputation for doing things in a large way; they operated the most powerful steam locomotives, had the largest coal cars with a capacity of 120 tons each, used the largest wrecking crane, and had under construction the finest and most modern coal pier, which pier is now almost ready to be placed in regular operation.

It is this pier which this article is intended primarily to describe, but perhaps a word relative to the other coal handling facilities at Hampton Roads, and a description of the old coal pier of the Virginian may be of interest.

Coal from the West Virginia fields is brought to tidewater Virginia by three railroads, viz.: the Chesapeake & Ohio, whose coal terminal is on the northern side of Hampton Roads at Newport News; the Norfolk & Western at Lambert's Point, and the Virginian at Sewall's Point; the latter two being at Norfolk. The Chesapeake & Ohio pier, and Pier No. 4, the most modern of the Norfolk & Western piers, are similar in most respects to Pier No. 1 of the Virginian.

The Virginian owns about 527 acres of land and about 141 acres of riparian rights at Sewall's Point, with a water frontage of about 3,150 feet on the Elizabeth River —a branch of the James.

On the east side of this tract are the engine house and shop facilities, repair tracks, and a receiving, classification, and coal storage yard. On the west side are the coal piers, yards, and other facilities in connection therewith.

The shop facilities consist of a five-stall roundhouse and repair shop, turntable, coaling station, water station, and repair tracks. There are also sufficient tracks for the storage of about 3,000 cars of coal.

There are two coal piers on the west side, No. 1, and No. 2. Coal pier No. 1 was constructed in 1909 and additions were made to this pier in 1918. Coal pier No. 2 has just been completed and is now being thoroughly tested out preparatory to being placed in regular operation.

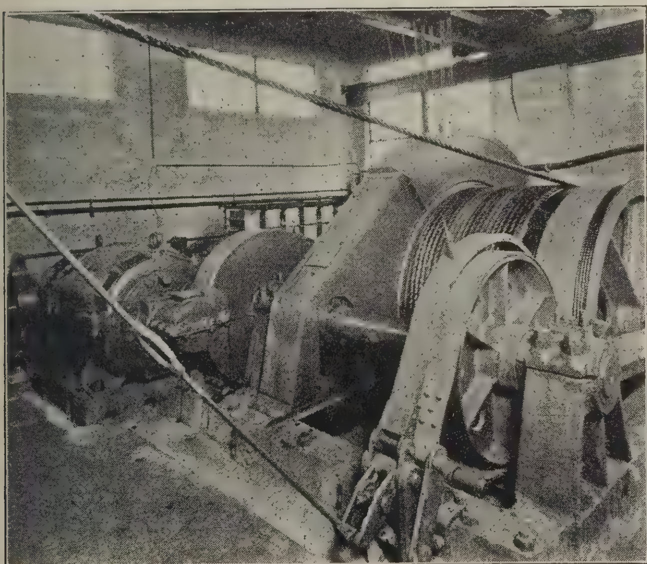
Both coal piers are operated electrically throughout. Power is purchased from the Virginian Railway & Power Company, the service being at 11,000 volts, 3 phase, 60 cycles, at the railway company's sub-station. This power is converted in the sub-station to direct current, 550 volts, for operating all the machinery; and is transformed to 110 volts alternating current for lighting the piers and yards.

The dumping capacity for pier No. 1 is 5,400 tons per hour and for pier No. 2—7,200 tons per hour, or a total capacity of 12,600 tons per hour for both piers.

Coal Pier No. 1

Coal pier No. 1 is 1,045 feet long beyond the bulkhead, 70 feet wide, 75 feet high at the inshore end, and 69 feet high at the outshore end.

The pier consists essentially of a steel superstructure on concrete foundations with 62 pockets, each of 60 tons capacity, and 62 adjustable chutes, 31 on each side; one car dumper and haulage for handling up to 70 ton capacity coal cars; one car dumper and haulage for handling one 120 ton or two 60 ton capacity coal cars; one incline haulage for handling 60 ton, electrically operated conveyor cars; one elevator for handling 120 ton, electrically operated conveyor cars; six 60 ton conveyor cars; six 120 ton conveyor cars; one 300 ton track scale; and yard tracks for loaded and empty coal cars.



Mule Haulage Driven by Two Direct Current Motors

The loaded coal cars are pushed over the hump with a switch engine into the loaded receiving yard. They are then dropped by gravity over the scales to a barney of the disappearing type, which hauls either two small cars or one larger car up on the cradle of the car dumper, where they are dumped into the electrically operated conveyor cars. The empty coal cars run by gravity from the car dumper to a kickback and thence to the empty car yard. The loaded conveyor cars are raised to the top of the pier, either by incline haulage or by elevator, the older side of the pier being by incline, the addition by elevator. They are dumped into the pockets on either side of the pier, from which the coal flows by gravity through adjustable chutes into the holds of vessels, where it is trimmed by hand labor.

Two large ships or three smaller ones may be loaded on each side of the pier at the same time. The minimum depth of water in the slips and approach channel to the pier is 32 feet below mean low tide, and on the south side of the pier the depth is 35 feet below mean low tide.

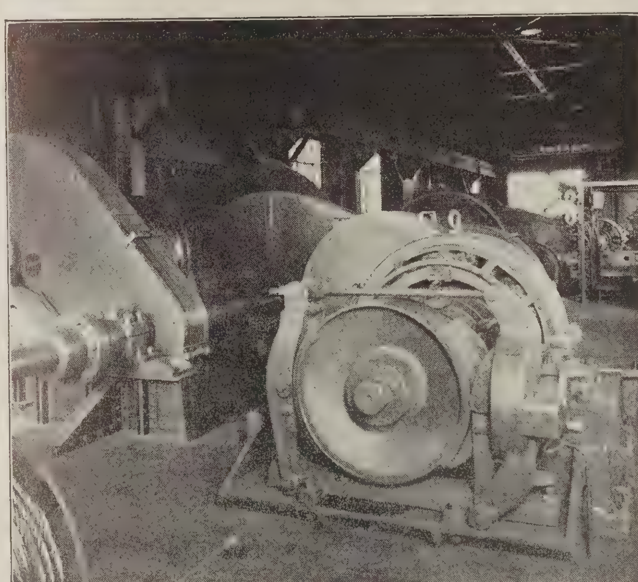
Coal Pier No. 2

Coal pier No. 2, the new pier, is located to the south of No. 1, with a slip of 319 feet between the two piers. It is approximately 1,074 feet long beyond the bulkhead, 86 feet wide, and 74½ feet high above mean sea level. The foundations have been constructed to provide for a depth of water alongside the pier of 40 feet below mean low water, which is the depth dredged in the channel of Hampton Roads by the United States Government. However the slips and approach to the channel have only been dredged to a depth of 35 feet below mean low water at this time.

The material dredged from the slips and channel has been used for filling in behind the bulkhead. The entire yards are on ground thus filled in, the highest point being elevation 30 feet at the hump.

The substructure of the pier is constructed of concrete cylinders on untreated piles. Beyond the bulkhead there is also a fender pier constructed of creosoted short leaf yellow pine timber. It encloses and is entirely separate from the pier so that vessels coming in contact with the timber structure will not damage the foundations or steelwork. The cylindrical concrete foundations support the steel superstructure.

The equipment in connection with the pier consists of two elevating car dumpers with haulages, each with a capacity for handling one 130 ton or two 65 ton coal cars; one elevator for taking empty conveyor cars to and from the top of pier; four travelling loading towers with mechanical trimmers, two on each side of the pier; four 130 ton electrically operated conveyor cars; one 300 ton track scale; and yard tracks for loaded and empty coal cars.



Equipment, Driven by Two 450 hp. Motors, Which Operates Elevating Car Dumper

Coal cars are dropped by gravity over the scales to an electrically operated mule haulage of the disappearing type, which pushes either two small cars or one large car upon the cradle of the car dumper. The car dumper then dumps the coal into a steel container, which is elevated and discharges the coal into 130 ton electrically operated conveyor cars on top of the pier. The empty coal cars are then pushed off the cradle by loaded coal cars, and run by gravity to a kickback and thence to the empty car yard.

The conveyor cars are similar to those on pier No. 1.

The body is mounted on two six wheel trucks and is divided into three compartments. These cars operate on top of the pier only and dump into the pockets of the traveling loading towers on either side of the pier, after which they return on a middle track to the car dumpers for reloading with coal.

The coal from the pocket of the travelling loading tower is fed on a steel apron conveyor operating in the boom of the tower and is conveyed to a telescopic chute at the end of the boom, through which it flows by gravity to a mechanical trimmer and thence either by gravity over a curved surface of the trimmer or is distributed by a high speed belt of the trimmer into the hold of the vessel. The traveling towers operating with the mechanical trimmers each have a maximum capacity of about 1,800 tons per hour, and about 2,500 tons per hour when the trimmers are not in use.

The travel of the loading towers along the pier and the movements of the boom, telescopic chute, and trimmer provide for loading all types of vessels at the pier.

The elevator is situated between the car dumpers, and is used only for taking empty conveyor cars to and from the top of the pier for repairs. It is operated at slow speed as it is used only occasionally.

The top of the pier is illuminated by a Westinghouse highway lighting unit; and a battery of six searchlights, a part of the yard floodlighting system, is located at the top of the car dumper structure.

Two large ships or three smaller ones may be loaded on each side of the pier at the same time.

The electrical equipment of pier No. 2 differs from that of pier No. 1 in that the control system is entirely separate, being furnished at 220 volts d.c. by a motor generator set, whereas all of the motors operate at 550 volts d.c.

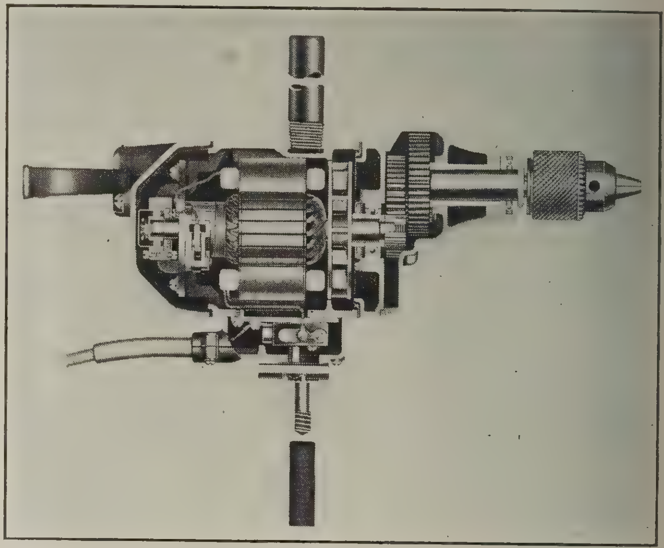
The coal handling machinery for the pier was furnished by the Alliance Machine Company, the motors for the car dumpers and haulages by the Westinghouse Electric & Manufacturing Company, and the control by the Cutler-Hammer Company. The pier was designed by F. F. Harrington, engineer of structures of the Virginian, and chief engineer of the Virginian Terminal Railway Company, a subsidiary of the Virginian Railway Company, with the assistance of J. E. Sharpley, electrical engineer, E. D. Hanes, superintendent of coal terminals, A. H. Chapman, office engineer, and H. G. Hodgson, assistant engineer of the Virginian, under the supervision of and with the approval of H. Fernstrom, chief engineer of the Virginian.

Standard Duty Half Inch Universal Drill

A standard ½ in. universal drill is a recent addition made by the Hisey-Wolf Machine Company, Cincinnati, Ohio, to its list of portable electric machine tools. It can be furnished with either a 115 or 230-volt motor with a no-load speed of 525 r.p.m. capable of drilling or tapping steel up to ½ in.

The motor is designed particularly for electric drill service. The armature is hand wound with the lead ends firmly banded in place. The heavy armature runs in ball bearings which cannot slip, as the inner races are locked. The bearing on the gear end of the armature is mounted with a floating fit in a hard cast in sleeve, which is intended to obviate binding and internal friction. A tooth type stator gives an efficient magnetic flux distribution. The brush holders with an adjustable spring tension are mounted as a separate unit on a bakelite yoke. This arrangement permits brush adjustment when necessary. At each end of the motor shaft are felt washers for retaining the lubricant. They are firmly held between steel collars to prevent them from working loose or wedging. The motor is cooled by force ventilation drawn into the motor by a fan keyed on motor shaft.

The electrically heat treated gear on the armature shaft is removable. The spindle gear is carried on an oversize chuck spindle which is hardened and ground and automatically lubricated through the gear case. The chuck end of this spindle runs in over-size thrust bearings. The chuck is fitted to a hardened and ground tapered spindle. The Jacob's chuck is standard equipment.



Removable End Plate Provides Easy Access to the Motor of This Machine

The end cover is a separate piece which carries all of the pressure applied to the spade handle, and being independent of the motor and motor bearing, relieves them of all strains. This construction also affords a convenient access to the carbon brushes for adjustment or renewal by the removal of three screws. The spade handle is directly in line with the drill chuck which tends to eliminate side pressure and reduce friction. For close quarter work it can be removed and the pressure applied directly on the end cover casting.

Telephone Connections with Moving Trains Are Being Experimented with in Germany—Connection Set Up by Induction Between Wires Strung Along Right-of-Way and Antennae on Roofs of Cars

Trucks on Charge in Charging Room No. 1

Electric Trucks in Transfer Service

Central of Georgia Now Has Fleet of 55 Trucks Operating at Full Capacity Under Trying Conditions

THE fleet of electric trucks used by the Central of Georgia at Savannah, Ga., for transferring cargo from ships to cars and from ships to warehouse has recently been increased to 55. These trucks are operated throughout the year at practically maximum capacity.

The fleet is divided into two groups, one of which is used for handling nitrate of soda in bags and the other for cotton, news print paper and miscellaneous freight. Load carrying trucks are used exclusively and all trucks are equipped with Edison storage batteries. The trucks used for cotton and miscellaneous freight are six Elwell-Parker SA straight frame—a baggage type truck—and six IY special trucks similar to the straight frame type except that the platform is lower. Each of these trucks is equipped with a battery consisting of 32 A8 Edison cells. The trucks used for carrying nitre are ten Baker DLQ freight type trucks, each equipped with 24, A-10-H cells, 16 Elwell-Parker FB freight type trucks equipped with 21, A6 cells and 16 Elwell-Parker EG elevating platform trucks equipped with 20, A8 cells. The freight type trucks and the elevating platform trucks are similar in appearance and are used for the same service. At present the elevating platform trucks are simply used as freight type trucks. A skid is placed on the platform and the elevating mechanism is not used.

Operation

The trucks are operated on five piers. Two of these piers have berths for three ships and three have two berths each. There is room for more, but only 12 berths are used. Many of the ships operate on dispatch and it is important that they be unloaded quickly. Twenty-eight trucks are used when discharging five hatches, five being used on each of four hatches and eight on the hatch with longest haul. A port record was made, 3,050 tons of nitre being unloaded from a single ship in 10 hours. The nitre is taken out of the ship by the ship's booms and dropped on the trucks in loads consisting of from eighteen to twenty-one 160 lb. sacks. From the ship's side the loaded truck is taken to the scales. The operator steps off the truck and the weigher takes the gross weight from which the weight of the truck is subtracted. Each truck of the same type is even weighted by means of lead adjusting weights carried in a small weight box mounted on the truck.

The truck proceeds from the scales to the car or the warehouse; it is unloaded by hand and is taken back empty to the ship's side. To reach two of the unloading platforms, the trucks must carry their load up a ramp which is 30 ft. long and has a 10 per cent grade. It is not uncommon to have 70 per cent of the cargo placed directly into cars and 30 per cent put in the warehouse. Usually each carload is a single consignment to a purchaser and accordingly cars may receive loads varying from 20,000 to 100,000 lb. A car hauled by a cable and motor-driven cable drum is used for switching and spotting cars along the loading platform. All of the truck operators are colored men.

The maximum distance the nitre trucks must travel is about 850 ft. and the minimum haul is about 300 ft. Each truck makes from 60 to 70 trips in a ten-hour day.

The service performed by the cotton trucks is similar in character except that the hauls are longer and there are no ramps to climb. The minimum haul is about 1,000 ft. and the maximum 3,000 ft.

The batteries on all trucks are charged every night. The charging station is located at Wadley street, about half a mile from Berth 25, where most of the nitre trucks are

used. At the conclusion of a day's work all of the trucks are run down to the Wadley street charging plant and are run back to the pier in the morning. Some of the trucks are used at the Wadley street berths.

The charging facilities occupy three rooms. One of these is 24 ft. square and contains a 150-kw. and a 75-kw. Westinghouse motor-generator set and the necessary switch gear. The charging current is generated at 125 volts and three sets of batteries are charged in series. The

Truck Entering Car with Load of Nitre—Note How Floor Planking Is Laid on Platform

amount of charging current is regulated by Cutler-Hammer sliding rheostat panels.

The other two rooms house the trucks while the batteries are being charged and flushed. One of these rooms is 24 ft. wide by 120 ft. long and the other is 24 ft. wide by 60 ft. long. These two rooms are fitted with charging receptacles mounted at regular intervals along the wall.

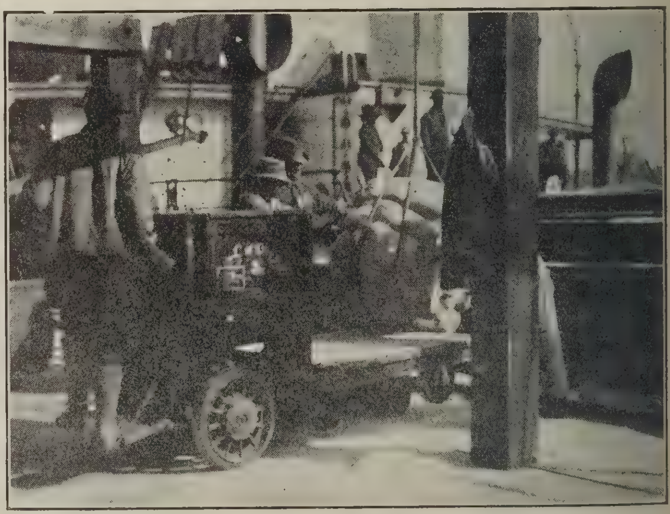
The Storeroom for Spare Truck Parts

When the trucks are driven in at night, they are lined up along the wall and connected three in series. They are charged at the seven-hour rate, the large motor-generator set being used to charge the 20 and 21-cell batteries; the voltage on the small set is boosted for charging the 24-cell batteries. The 32-cell batteries are charged two in series from the large motor-generator set. There are 24 charging circuits available.

The A8 and the A6 batteries are flushed every night

Truck Batteries Being Flushed in Charging Room No. 2

and the A1OH batteries are flushed every other night. The flushing device consists of a metal barrel or drum mounted on two wheels. An automobile tire pump is mounted on one side of the barrel. The barrel is filled partly full of distilled water and air pressure is applied by the pump. Thirty feet of hose is connected to the barrel at the bottom and the other end of the hose is fitted with



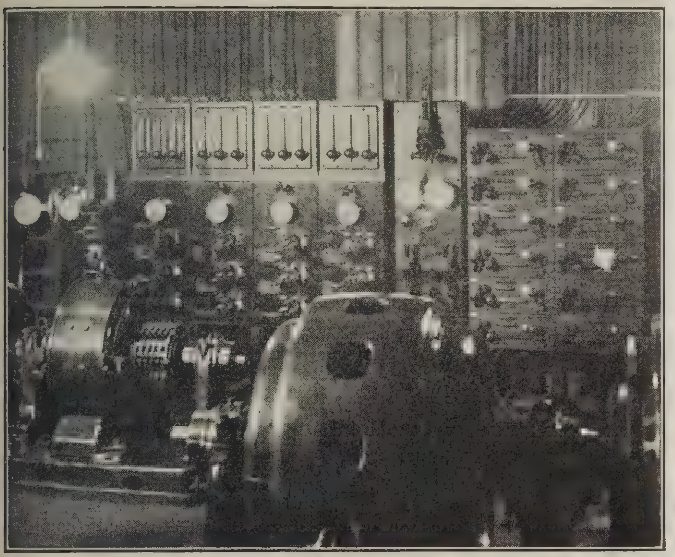
Truck Receiving Load from Ship's Boom

an Edison battery filler. The distilled water is made in a water still owned by the railroad.

All of the trucks are fitted with Alemite lubrication, and bearings are greased at intervals with a high pressure Alemite gun while the batteries are being charged.

The batteries on the type EG and FB trucks are also given a boosting charge of one hour at noon. This is done with a 25 kw. motor-generator set and two mercury arc rectifiers located in the repair shop near Berth 25. The other trucks do not need a boosting charge as they have larger batteries.

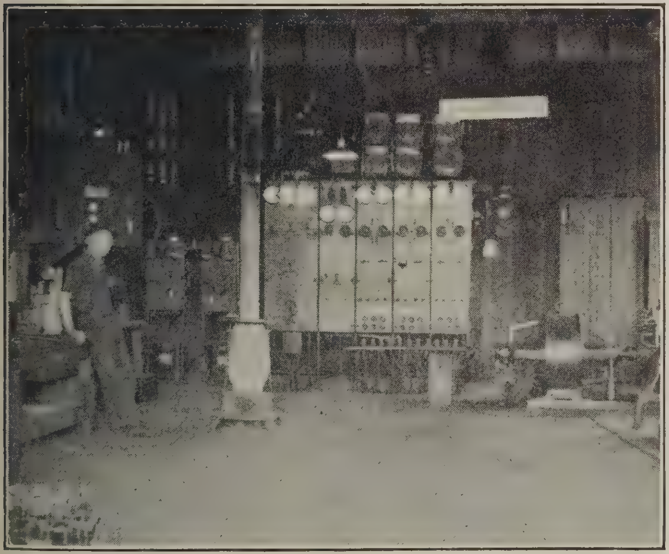
All repair work is done in a one-story building which measures 24 by 40 ft. Trucks which require a boosting charge are placed around this building during the noon hour at points where charging lines are brought out through the side wall. A 16-ft. addition at one side of the building provides additional working space when



Substation in Which Charging Current Is Generated

necessary and affords protection to trucks receiving a boosting charge in bad weather. A small addition not shown in the illustration is used as a storeroom for spare parts.

The workroom is equipped with a lathe, drill press,



Interior of Repair Shop

grinder, small belt-driven air compressor for cleaning and painting, electric and acetylene welding facilities and bench and hand tools.

Batteries on the nitre trucks are cleaned and painted every six months at which time the solution or electrolyte is renewed where the gravity is found to be below standard. Batteries on the cotton trucks are cleaned and painted only once a year. The reason for the difference is that the nitrate of potash gets onto the batteries in spite of all the precautions that may be taken to prevent it.

Nitre truck batteries average from five to six years' service before it is necessary to return them to the factory for recanning and reconditioning. The cotton truck batteries have shown an average life of about 10 years and a few of them have been in service 13 years. Batteries on the nitre trucks are at times transferred from one truck to another, but cotton truck batteries are never used on nitre trucks.

Rear bearing and steering knuckle repairs constitute a large part of the maintenance work done. This is due to corrosion caused by the nitre and by the dropping of heavy loads from the ship's boom to the truck. The main-

Repair Shop

tenance work is done by a mechanic and two helpers and one mechanic and two helpers care for batteries.

The cost of handling material with the trucks has been found to be just about half the cost of doing the work with hand trucks, not including overhead or fixed charges. Including overhead, the saving effected is estimated at 30 per cent. The cost of maintaining and operating the trucks during the year ending July 31, 1924, including

Truck on Scales en Route from Ship to Car

cost of charging current, labor of six maintainers, cost of renewals and 10 per cent for depreciation was $998. These costs are being gradually reduced month by month and the indications are that they will total only about $800 for the year ending July 1, 1925. This reduction has been

effected principally by improved methods of maintenance and operation. New flooring was laid on the nitre piers recently and the planks were laid longitudinally instead of crosswise as they had been originally. This change reduced wear and tear on the trucks considerably.

The trucks are maintained and kept in running order by W. C. Black, electrical foreman, under the supervision of T. A. Johnson, electrical engineer.

Brush Installation*

THE preceding articles of this series have dealt with commutator care, causes of sparking, brush characteristics and brush finishing. The next logical subject is the one we have selected—that of brush installation. This subject covers many points, and we will endeavor to give some of these in a way which will be of practical value. There may be several cases overlooked in this discussion, but we will attempt to point out the various methods of installation of brushes as applied to standard types of motors and generators.

The selection of brushes as covered in a previous article deals only with the various grades as demanded by the electrical requirements of the machines. The selection of the proper size of brush depends upon the style or type of brush holder, type of machine, etc. The holders most generally used are the box type, clamp type and reaction type holders.

In the box type holder the brush must be free to move so that, as the brush wears away, the pressure spring can keep the brush in contact with the commutator. In this type the brush may or may not be provided with a shunt. In case no shunt is provided, the current passes through the holder and pressure spring. The brush in the clamp type holder is fastened rigidly, the entire holder being actuated by a spring giving the desired brush pressure. The spring hammer of the reaction type holder, acting upon the beveled end of the brush, together with the reaction of the commutator, keeps the brush securely in place, up against the back of the holder.

If the proper dimensions are given to the brush manufacturer, the brush should fit into the holder without difficulty, since all dimensions of the brush are carefully machined. Brushes should fit snugly but not tightly in box type holders. The movement of the brush in the holder due to either a worn holder or undersized brushes changes the angle of contact and results in poor commutation, particularly on motors which operate in both directions. Consequently, extreme care must be taken to see that the brush fits properly in the holder, and, if this is done, much of the sparking, chipping of brushes and overheating, which is frequently blamed upon the brush itself, may be eliminated.

It is a rare thing to have a new brush fit the commutator surface correctly, and, consequently, brush engineers recommend that brushes be "sanded in." The rough sanding is accomplished by placing a long strip of sandpaper between the commutator and the brushes to be sanded, moving it back and forth until the brush face conforms approximately to the shape of the commutator. Some engineers maintain that the final sanding, if possible, should be done in the direction of rotation, in order to get a perfect fit. The final sanding of brushes on the reaction type holders or brushes of large bevels should be done toward the side of the holder against which the brush rests when in operation. Proper sanding is especially important on machines which are to be operated under full load without allowing sufficient time for the brush to wear to face.

Sparking and glowing at the brush face are sometimes the result of a poor connection where the shunt terminals are fastened to the studs. A loose connection will cause the remaining brushes to carry more than their share of the load, which results in excessive heating. In the installation, therefore, the following points should be observed:

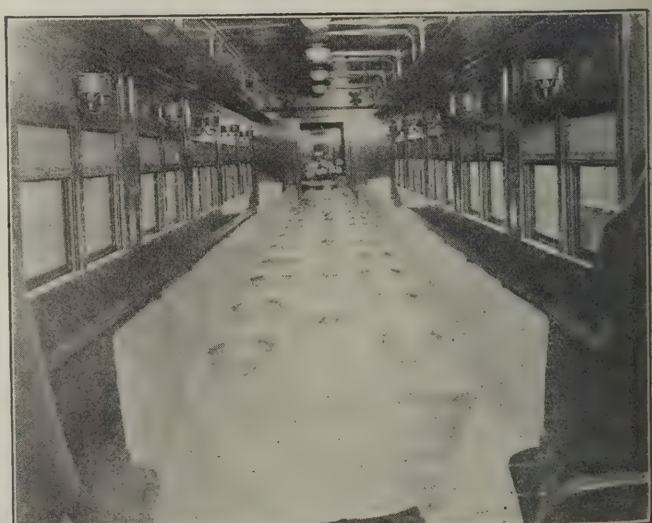
1. The brush should fit holder properly.
2. The brushes should be properly sanded.
3. The shunt connections should be tight.

Next in importance to the installation of the brushes is the setting of the various groups of brushes on the electrical neutral. This may be accomplished in two ways: 1. by trial, i.e., setting the brushes nearest the theoretical neutral at which the minimum of sparking occurs. 2. By means of a voltmeter.

Brush pressure is perhaps as important an item as any, and one which causes a good deal of trouble. High brush pressure causes excessive brush or commutator wear and heating due to the high friction. Low brush pressure gives a poor contact and causes sparking and heating. A good general rule to follow is to use the lowest brush tension that will give good contact. This is seldom under 1¾ pounds per sq. in. for stationary machines, except with some graphite brushes which can be operated at tensions as low as 1¼ pounds per sq. in. For the railway service, 3½ to 8 pounds per sq. in. pressure is generally used, depending upon the speed of cars and conditions of track. For crane motors, truck motors and similar machines, where vibration is severe, the brush pressure should be about the same as for railway motors.

The short circuit current is an evil which may be guarded against by the proper selection and installation of brushes. If the following five points are kept in mind the trouble due to short circuit currents will be eliminated.

1. Brushes must be at correct commutating points.
2. Correct brush spacing.
3. Proper spanning of commutator bars.
4. Brush settings parallel with commutator.
5. Proper brushes; that is, brushes with proper electrical characteristics.



Banquet Car Originated by President Budd of the Great Northern

* From a Bulletin issued by the National Carbon Co.

New 60-Ton Oil-Electric Locomotive

Oil-Electric Locomotive Performance

Reduction in Fuel, Lubrication, per 1,000-Ton Miles and Per Mile Costs Are Obtained—Stand-By Losses Reduced

IN 1923 the American Locomotive Company, the Ingersoll-Rand Company and the General Electric Company built jointly the first oil-electric locomotive in America, a description of which was published in the *Railway Electrical Engineer* of June, 1924, page 183. After four months' service in the yards at the Ingersoll-Rand plant at Phillipsburg, N. J., it was loaned to a number of railroads and industrial plants for switching service. On June 9, 1924, it was placed in service for a practical test on the New York Central in its freight yards on the west side of New York City. Up to July 9, 1925, it has been used by 14 different railroads and industrial plants during which time complete data have been recorded daily as to its performance. The following table is a resume of the data obtained while the locomotive was in service on different roads:

	Hours	Load Factor	Cost in Cents Per Locomotive Hour	Cost in Cents Per Kilowatt Hour
New York Central	833	13	29.7	1.645
Baltimore & Ohio	81	12.25	33.3	1.53
Central of N. J.	35	8.7	28.7	2.02
New York, New Haven & Hartford	271	21.2	32.7	.946
Union Freight	40	9.5	19.8	1.46
Boston & Maine	132	14.1	32.7	1.32
Long Island	128	20.6	34.9	.964
Long Island	234.5	18.9	36.0	1.27
Bethlehem Steel Co.	9	30.15	57.5	1.075
Reading Co.	207	18.10	44.9	1.45
Delaware, Lackawanna & Western	120	19.85	46.7	1.34
Hoboken Shore	26	13.1	38.0	1.76
New Jersey Zinc Co.	79	27.3	62.8	1.30
Alan Wood Iron & Steel Co.	32	27.45	58.6	1.24
Total hours	2,227.5	*16.6	34.3	1.41

* Average.

Performance

Some of the results of the experimental service are significant. The locomotive was in switching service on the New York Central from June 9 to August 23, 1924, part of the time in 24-hour service, handling three shifts a day with only such inspection as was possible at the time of changing crews. The regular crews handled the locomotive, it requiring only about 15 min. for a demonstrator to show how the locomotive was operated. During this time the locomotive was in service 833 hr. of which 579.33 hr. constituted the actual time the unit was in operation which gives 253.66 hr. as idle time during which the oil engine was shut down. During this time there were 115,866 kw. hr. available of which 15,063 kw. hr. were generated which gives an engine load factor of 13 per cent. If the locomotive was idle more than ten minutes, the engine was shut off, which factor considerably reduced the stand-by losses. During its operation on the New York Central the unit used 2,400 gals. of fuel oil, equivalent to 4.14 gals. per hour of locomotive operation. An interesting feature developed in connection with fuel consumption was that on the average, one tank car of fuel oil used in the locomotive would do as much work as 12 cars of coal burned in the steam switching locomotive for which the oil-electric locomotive substituted. Inasmuch as the oil-electric locomotive can carry sufficient fuel oil for 48 hrs. operation, delays due to taking fuel were reduced to a minimum. There were also no delays due to taking water and no handling of ashes. While on the New York Central the locomotive moved 400,000 ton-miles, or 166 ton-miles per gallon of fuel. With a load factor of 13 per cent, the locomotive produced 6.3 kw. per gallon of fuel. At full load it is capable of developing about 10 kw. hr. per gallon.

The locomotive is provided with a distance speed recorder to determine the average mileage actually made by the switch engine replaced. It was found that the mileage

was not quite three miles per hour. This is an interesting figure in comparing steam locomotive mileage figures for switching service as it should be borne in mind that an arbitrary figure of six miles per hour is the common factor used in computing railroad statistics.

The following table has been compiled to show in greater detail the performance of the locomotive under various conditions.

	Switching Service	24 Hr. Per Day Switching Service	Main Line Local Frt. Service	Light Yard Drilling
Total hours of locomotive service..	833	280	10	35
Total hours of oil engine operation.	579.33	164	9.24	28.66
Total kw. hours generated........	15,063	4,098	520	499
Per cent load factor..............	13	12.05	28.2	8.7
Total gallons fuel consumed.......	2,400	672	54.5	80.75
Total gallons lubricating oil consumed	249	80	4	12
Total cu. ft. cooling water consumed.	67	neg.	neg.	neg.
Total gallons gasoline consumed...	30	neg.	neg.	neg.
Cost of operation (fuel plus lubricating oil plus water plus gasoline)	$247.86	$73.60	$4.72	$10.37
Cost of operating per hour of locomotive service	$0.297	$0.265	$0.472	$0.297
Cost of operation per kw. hr. generated—in cents	1.645	1.8	0.91	2.08
Total ton-miles	400,000	112,930	16,615	.....
Cost of operation per 1,000 ton-miles	$0.67	$0.652	$0.284	.....
Miles traveled	1,531	466	47	42
Cost per mile....................	$0.162	$0.158	$0.10	$0.239

Note—Cost of operation shown above based on the following prices:
Fuel oil at 5 cents per gallon.
Lubricating oil at 50 cents per gallon.
Cooling water at $1.00 per 1,000 cu. ft.
Gasoline at 11 cents per gallon.

Three curves have been plotted from the performance data, the analysis of which develops some interesting facts.

Passenger Train Test on the Reading with Oil-Electric Locomctive

The power cost per kilowatt-hour curve shown in Fig. 1 indicates that as the load factor increases, the power cost decreases. The drop in cost is abrupt from a 5 per cent to a 30 per cent load factor. From here on to 60 per cent the curve gradually flattens out and then maintains an approximate straight line to 100 per cent load factor. Thus, it can be seen that this locomotive should be operated at a 60 per cent load factor to obtain the minimum cost per kilowatt-hour.

The curve for power cost per locomotive hour is shown in Fig. 2. Between the load factors of 5 and 20 per cent, the curve is steep and if it continued in this fashion, would, at approximately 50 per cent load factor, reach a cost of $1.05 per hour, which figure is shown for a 91 per cent load factor. However, at 20 per cent load factor the curve shows a power cost of $0.43 and then gradually slopes off and at 100 per cent load factor shows a power cost per locomotive hour of $1.10.

The curve for fuel oil per kilowatt-hour is shown in

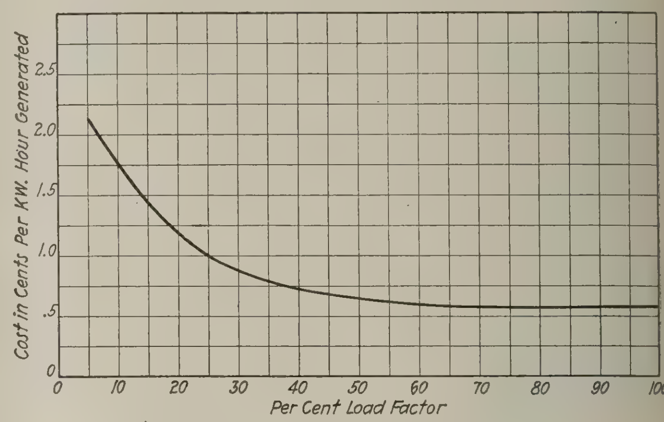


Fig. 1—Power Cost Per Kilowatt Hour

Fig. 3. From a load factor of 5 per cent to one of 20 per cent the fuel oil cost per kilowatt-hour decreases 4.5 cents, 20 to 30 per cent load factor, 2 cents and from 30

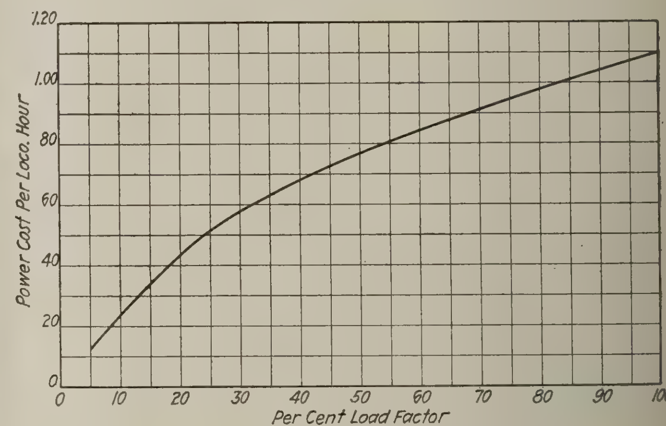


Fig. 2—Power Cost Per Locomotive Hour

to 40 per cent load factor one cent. From this point on to 100 per cent load factor the fuel cost per kilowatt-hour remains about 0.9 cents. Thus, it can be seen that the

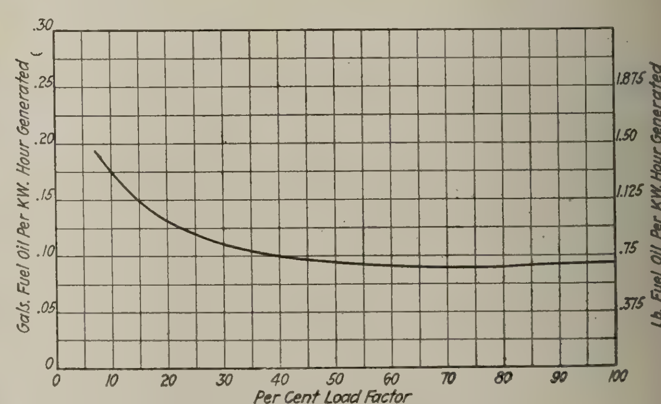


Fig. 3—Cost of Fuel Oil Per Kilowatt Hour

greater the load factor up to about 50 per cent, the less the cost of fuel consumed.

Another factor to be considered in the operation of this locomotive is the amount of wear of the various parts. In order to determine this, a system of regular inspections

has been maintained. The first inspection was made February 12, 1924, and seven months later, on September 12, the second inspection was made. The results obtained from these inspections are shown as follows:

Cylinder bore	.0005 to .001 inches wear. Cylinder appearance was excellent.
Pistons	Practically showed no wear since last inspection. Carbon on piston heads very light.
Piston rings	Appearance excellent, showed practically no wear, all the rings were free and in good condition.
Wrist pins and bearings	.001 to .008 of an inch wear. Appeared to be in fine condition.
Crank pins	.001 to .004 of an inch wear.
Main bearings	.0025 to .005 of an inch wear.
Air and exhaust valves	Both in excellent condition; showed practically no pitting and very light carbon.

After the crank pin, wrist pin and main bearings were set up to standard clearances the engine was closed exactly as it was taken apart as it was found unnecessary to renew any parts. The following is the data for the 60-ton oil-electric locomotive for slow switching service.

Engine

Type of engine	Ingersoll-Rand, 4 cycle vertical
Number of cylinders	Six
Cylinder dimensions	10 in. bore by 12 in. stroke
Speed	[illegible]00 r. p. m.
Capacity	[illegible]00 hp.
Fuel	Fuel oil
Fuel injection	Direct injection
Fuel distribution	Rotating distributing valve
Lubrication	Forced feed with filtration
Lubricating pumps	Pressure pump and filter in crank case
Cooling	Water cooled
Radiator	Fin tube roof type 1,200 sq. ft. surface

Engine

Temperature control	Thermostat and by-pass
Fuel consumption	0.43 lb. per boiler hp. hr.
Piston speed	1,200 ft. per min.

Generator

Type	TDC-6-200 kw., 600 r. p. m. 600 volts
Exciter	6 kw. direct connected, 60 volt
Shunt windings	Separately excited
Series winding	Differential compound
Voltage variation	200 to 750 volts

Motors

Number of motors	4—Type RM—840, nominal rating 95 hp., each 600 volts
Connection	2 in parallel—Series and parallel grouping
Gearing	14 tooth pinion, 82 tooth gear.

Control

Method of control	By throttle lever—Automatic control of voltage 2-C-173-A controllers with electro-magnetic contractors and reverser
Battery (for lighting and control)	16 cells MV-7 Exide ironclad

Compressors

1—Type CP-26-600 volt with a piston displacement of 100 cu. ft. per min. for air brakes.
1 Mechanically driven pump mounted on engine furnished air for starting.
1 Auxiliary engine driven compressor to furnish air for starting the oil engine.

Locomotive

Length inside knuckles	32 ft., 6 in.
Width of cab	9 ft., 4 in.
Trucks	2 axle swivel type
Width overall	10 ft.
Rigid wheel base	7 ft., 2 in.
Weight complete	120,000 lb.
Weight on drivers	120,000 lb.
Weight on each axle	30,000 lb.
Tractive effort	36,000 lb. at 30 per cent factor of adhesion maintained to one m. p. h. (approx.)

Underwood & Underwood

Nenana River Canyon, Alaska, Showing Government Railroad

THE INTERCHANGE

A Radio "B" Storage Battery

A. H. Matthews, Electrician
Canadian National Railway, Quebec, Canada

The so-called "B" batteries used so extensively in radio receivers form a very necessary part of the equipment. Some receivers require so much current from these batteries that some type of storage battery may be desirable. A good home-made storage "B" battery can be made from the following materials: Fifty 6-in. by 1-in. glass test tubes, a wooden box about 15-in. by 8-in. by 8-in. with cover, a rack to fit inside of the box and some sheet lead, a double pole knife switch, 8 large binding posts, and 5 ft. of lead wire or lead strip.

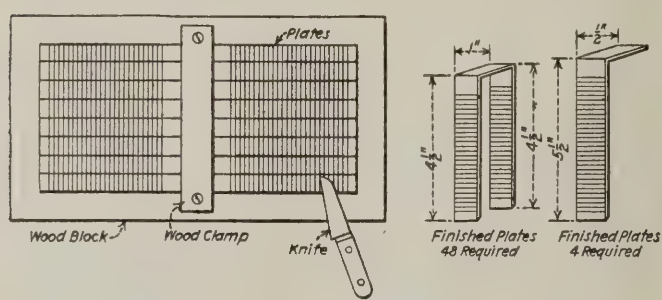


Fig. 1—Method of Preparing the Plates for the Battery

Bore 50 holes 1⅛-in. in diameter in the rack, the holes to be about 5/16-in. between edges. Paint or varnish the rack and inside of the box and push the test tubes into the holes. It is sometimes better to bore a 1-in. hole instead of a hole 1⅛-in. as the tubes vary a little and should be fairly tight or they will shake about and break.

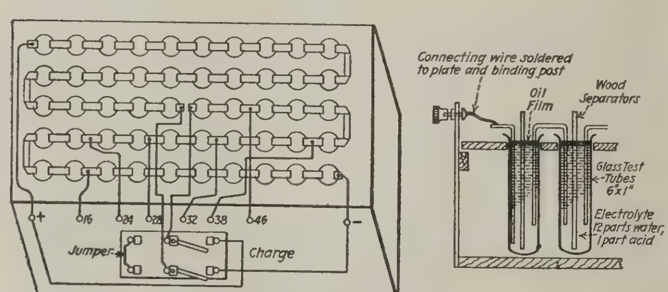


Fig. 2—Sketches Showing Assembly and Details of Tube Cells Composing the Battery

Mount the binding posts in line on the front of the box and the switch in the center.

Cut 48 pieces of sheet lead 10-in. long, ¾-in. wide and about ⅛-in. to 1/16-in. thick and 4 pieces 6-in. long. These are deeply marked with a pointed knife. To do this, place them flat, side by side and hold them with a board and screws as shown in Fig. 1. When this has been done the plates are ready to be placed in the test tubes. Fifty separators will be needed. These can be made of wood or hard rubber.

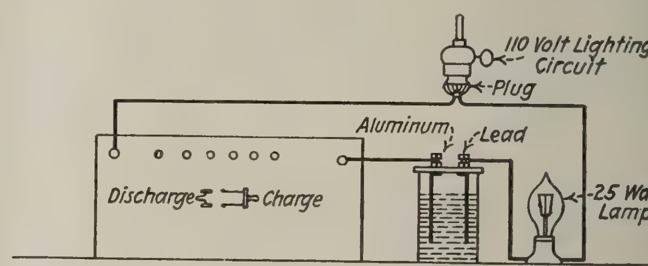


Fig. 3—Circuit Connections for Charging the Battery

The cells are connected to the binding posts and switch with the lead strips or wire and soldered to the various connections. Paint the brass screws with melted wax. The completed job is shown in Fig. 2. The electrolyte is made by mixing one part sulphuric acid to 12 parts pure water, pouring the acid slowly into the water. The liquid must be stirred with a clean stick and as the mixture becomes hot it must be allowed to cool before using. When cool, pour the electrolyte into the test tubes to within ¾-in. of the top and on top of this add a little thin oil.

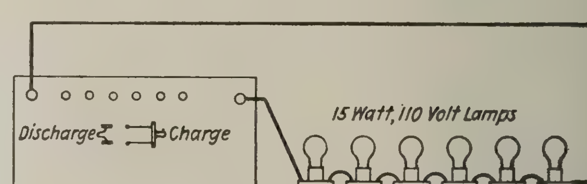


Fig. 4—Arrangement Used to Discharge Battery While Forming Plates

To charge the battery you will need a rectifier. To make this, obtain a small jar about one pint size. Make a wooden cover for it and cut a piece of lead or sheet iron as deep and as wide as the jar and fasten it to the cover with a binding post. Next obtain a piece of pure aluminum rod or sheet of same length as the jar and about ¼-in. to ⅜-in. in diameter. If sheet aluminum is used about 1-in. wide will do. Fasten this to the cover with another binding post. The electrolyte used in this

jar is a saturated solution of ammonium phosphate. Borax and water or bi-carbonate of soda and water may also be used. The connections for charging the battery are as shown in Fig. 3. Charge for 24 hrs. and then discharge through a high resistance such as a pair of phones or six 15-watt, 110-volt lamps in series will do, as shown in Fig. 4. The idea is to discharge the battery slowly. When completely discharged, charge again for 24 hours. This cycle of charge and discharge should be carried on for five or six times. After the last discharge, reverse the connections from the rectifier connecting the aluminum to the left hand battery post and repeat the charge and discharge five or six times as before. You can now mark the battery posts, the left hand one being positive and the right hand one negative. The idea of reversing the battery is to develop and build up the plates. Do not hurry the first step in charging as on this depends the future capacity of the battery. When properly built this battery will light a 15-watt lamp for one hour or more. I have one of these batteries working a five tube set with loud speaker and I have found that a 15 minute charge is sufficient to operate the set for an entire evening's entertainment.

He Knew the Act

The Chief Clerk had the Superintendent as his guest for dinner. The dinner was a very quiet affair, but while dessert was being served, the host told a story.

When he had finished, and the laughter had ceased, his little son exclaimed delightedly:

"Fine, Pop, now tell the other one."

An Electrical Courtship

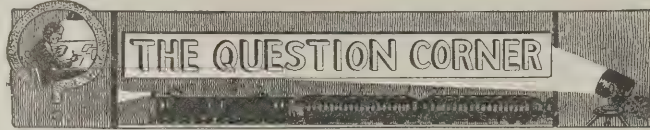
Young "Eddy Current" met "Poly Phase," and
as she was alone
He made a break to undertake to "conductor"
to her "ohm."
The "electrolyte" was burning bright,
they took a hurried gait
For fear her folks they would displease
forgetting "insulate."

With "oscillating" heart beats and
emotional "alternations"
The couple "reeled" across the "field"
to meet her "phase relations"
The lad proclaimed a boundless love
forever to endure,
He wished to wed, but father said,
"Wait till you 'armature.'

"The plan," said he, "is quite a shock, and
quite against the rule,
First you must bring a collector ring
set with the proper 'joule.'"
So Eddy found the family against him
to a man,
From far and wide from every side
"resistance" to his plan.

What could he do but yield to them,
so after due reflections,
With heart felt sighs and amorous eyes,
they broke off all "connections."

The moral of this little tale as told me
by the writer
"If you can't control a girlie's dad, be
wise and don't Exciter."



Answers to Questions

1—*How can you tell when the electrolyte of a cell is contaminated with iron impurities?*

2—*Explain just how iron impurities in electrolyte causes the local discharge of a cell.*

3—*How can you tell when a cell has copper in the electrolyte?*

Impure Electrolyte

1—A simple chemical test would readily determine the presence of iron impurities in the electrolyte of a cell. Take a sample of the electrolyte and place it in a glass test tube and add a few drops of a weak solution of potassium permanganate and then add a few drops of a solution of sulphocyanide. This will cause the solution to turn red if much iron is present, and the more iron present, the redder will be the solution on test.

2—When a flake of iron rust falls into the sulphuric acid electrolyte it is immediately dissolved, forming a sulphate of iron. This sulphate of iron, however, has the peculiarity of being able to exist in two different states—ferrous sulphate and ferric sulphate, the latter containing more oxygen than the former. It is very easily changed from one state to the other and in doing so acts as a chemical transfer agent for removing oxygen from the peroxide (PbO_2) of the positive plate, and depositing it on the lead sponge (Pb) of the negative plate, forming (PbO) on both plates. The ferrous sulphate in solution near the positive (PbO_2) plate takes oxygen away from that plate, forming ferric sulphate and (PbO). This ferric sulphate in solution diffuses through the electrolyte and arrives in the negative plate which deprives it of oxygen taken from the positive plate and changes it back to ferrous sulphate. The negative plate, however, in doing so, oxidizes some of its lead sponge active material (Pb), changes it to the oxide of lead (PbO) which represents the discharged condition of that active material. Thus by purely chemical means, the plates of that cell are discharged and the result is practically the same as if a discharge current had flowed through the cell.

3—The presence of copper in the electrolyte of a cell may be determined by the following test: Put the cell on charge for a few minutes and then put a sample of the electrolyte in a glass test tube. Add pure ammonia slowly. If copper is presented in a serious quantity the solution will first turn to a bluish milky color; adding more ammonia will clear up the milky cloudiness of the test sample and turn it to a deep blue clear solution, the intensity of the blue color depending upon how much copper is in the electrolyte.

Questions for August

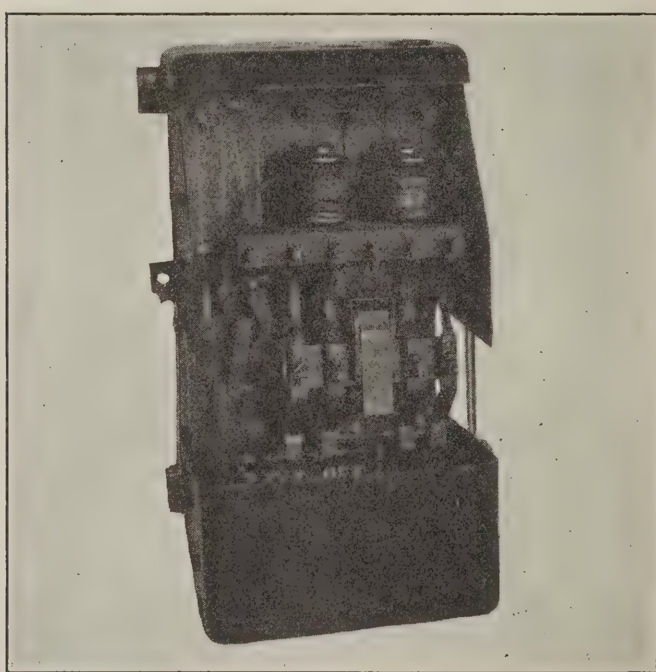
1—*Give a simple explanation of power factor.*

2—*What is meant by wattless current in an alternating current circuit?*

NEW DEVICES

New Starting Switch

The Electric Controller & Mfg. Company has just introduced a new push button operated oil switch for starting squirrel cage induction motors directly across the line. This device is known as the Type ZO starting switch and is controlled from one or more push button stations which may be located at convenient points. The



Push Button Oil Operated Switch for Starting Squirrel Cage Induction Motors Directly Across the Line

switch is provided with four pairs of heavy contact fingers,—three of which handle the main line in the case of three phase or two phase three wire motors, and the fourth pair handles the control circuit to the push button when the switch is arranged for no-voltage protection. In the case of two phase four wire switches all four lines are disconnected in the "off" position when the switch is wired for no-voltage release. When wired for no-voltage protection one line runs direct to the motor.

The Type ZO starting switch uses a very accurate inverse time element temperature overload device which consists of 2-alloy wires each, attached at one end to an adjusting screw, and at the other end to a multiplying lever which operates a quick make and break contact, the wire is connected across the secondary of a small current transformer. The gage of the expansion wire and the winding of the secondary of the transformer remains the same regardless of the horsepower ratings, or voltage, of the switch and the size of wire and number of turns of the primary is proportioned to suit the rating of the motor. An increase in current or an overload on the motor produces an increase in the current flowing in the secondary circuit, which causes the expansion wires to lengthen and, if the overload is severe enough or, is of sufficient duration, the wires lengthen sufficiently to trip the overload relay contacts causing the starting switch to open and disconnecting the motor from the line. The wires then cool and the overload relay contact automatically resets if a switch is wired for no-voltage protection. A hand reset of the overload device by means of a small button projecting through the case is provided on switches arranged for no-voltage release.

The overload device protects the motor against injury due to phase failure. If an attempt is made to start the motor with one phase open, the switch will open in less than five seconds, and the manufacturer states that it is impossible to burn out a motor due to phase failure or overloading when protected by this starting switch.

The oil tank is drawn from a single piece of sheet steel and can not leak oil. The tank latches are arranged so that the tank can be lowered and left suspended to catch oil dripping from the contacts while the switch is being inspected.

On account of creepage of oil due to capillary attraction and from a slight splashing when the magnet surfaces engage, all moving parts of the switch are kept lubricated, which protects the switch from corrosion when installed in corrosive atmospheres.

The Type ZO switch is arranged for conduit connection and is of compact dimensions, 13 in. high by 9 in. wide.

Armored Weather-Proof Connector

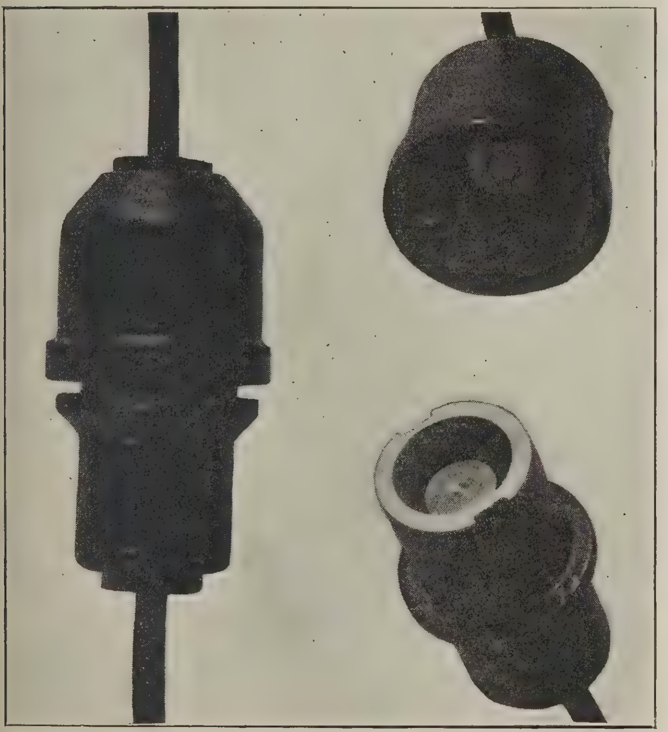
A weather-proof connector which is intended to make it possible to instantly connect and disconnect with the line without the use of tape or tools, motor driven portable welders or other portable machines has recently been

developed by the Ohio Electric & Controller Company, Cleveland, Ohio.

The socket end of the connector should always form the upper part so that any water which may fall on it will be readily drained off and not enter the connector. Asphaltum compound is filled in around the cable where it goes through the insulator so that no water can enter at this point.

In the lower or socket end of the connector, the contact is a loose fit in the insulator and is supported by a compression spring, current being carried around the spring by means of six flexible conductors. This flexible support is to insure a solid electrical contact between the upper and lower halves. When the two parts of the connector are open, the live contacts are protected by the skirt of the armored shell which extends an inch beyond the contact points.

A short piece of No. 4 B. & S. flexible cable is soldered



Weather-Proof Connector Adaptable for Motor Driven Portable Machines and Cranes

to each end of the connector and, for a short time this cable is capable of carrying 1,000 or 1,200 amperes. The continuous capacity of the connector is 150 amp. which it can carry under test with a rise of 10 deg. C. Intermittent capacity such as would be encountered by a crane motor is 300 amp. It is made only in one size, weighs 3½lb. and can be furnished as a two or three pole connector when desired.

Portable Electric Circular Wood Saw

A portable electric circular saw adaptable to trimming car flooring and roofing and suitable for general use about a car shop or repair yard, has recently been developed by the Crowe Manufacturing Corporation, located in Cincinnati, Ohio.

The body of the tool is made of aluminum which makes it light in weight and easy to handle. Every part is machined and is interchangeable. The smaller size, which weighs 15 lb., has a cutting capacity, with an 8-in. blade, of 2½ in. and the larger size, which weighs 25 lb., with a 12-in. blade, will cut material 4½ in. thick.

The motor used is of the universal type, especially designed for this kind of tool. It can be supplied for either 110 or 220 volts. The saw is equipped with a trigger switch, the purpose of which is to insure safety, as the operator's finger must be held on the switch in order to keep the motor running. The motor fan and shafts are

An Electric Hand Saw for the Car Man

dynamically balanced in order to eliminate vibration while in operation. It is provided throughout with heavy duty ball bearings.

In operation, the front guide is rested flatly on the material to be cut before starting the motor. It is always advisable to keep the cutter away from the material until after the motor is started, then the saw blade is fed into the material, always keeping the finger on the trigger. After the cut is completed, the trigger is released and the tool removed for a new cut.

The device is furnished with an electric light extension cord fitted with a plug which may be attached to any standard light socket.

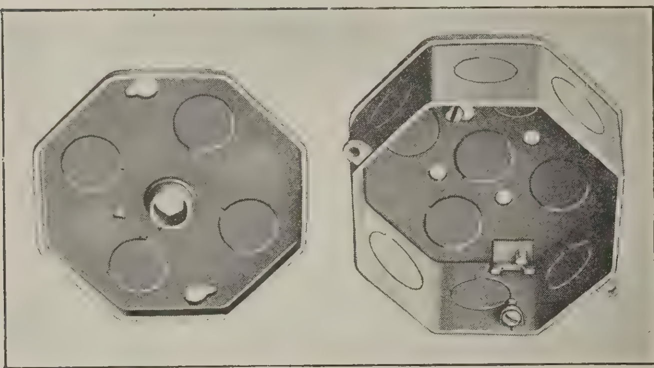
Outlet Box for Concrete Construetion

Improvements have been made in the line of "Union" outlet boxes manufactured by the Chicago Fuse Mfg. Co., Chicago, for use in buildings of concrete construction. These boxes are provided with flanged back cover plates which can be removed. After the required number of knockouts have been taken out the conduit can be attached and the box nailed to the wooden form. After the concrete has been poured and allowed to set, the wooden form can be torn away, the openings in the box affording easy access for fishing wires through the conduit.

The boxes are octangular in shape, six sides having ½-inch knockouts, and two sides which are directly opposite one another having ¾-inch knockouts, so that the main line wires can run straight through and the branches can be fanned out to the ½-inch conduit. Wiring

is made easy by this arrangement and by the roominess of the box.

One type of back cover plate has five ½-inch knockouts, and four holes untapped for standard fixture studs, while



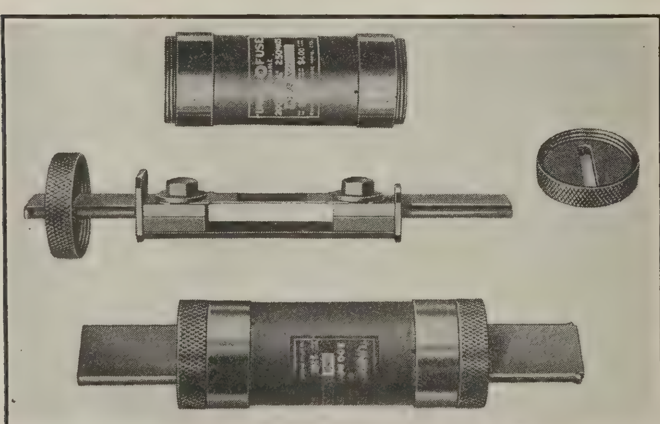
Arrangement of Knockouts in New "Union" Outlet Box

the other type has four ½-inch knockouts and a fixture stud, the latter being made an integral part of the box by a special process used exclusively by the Chicago Fuse Mfg. Co.

Renewable Fuses Simplified in Construction

A new development in the design and construction of electrical fuses has recently been made by the Chicago Fuse Mfg. Co., of Chicago, manufacturer of electrical protecting materials and conduit fittings. It consists of modifications in the company's line of "Union" renewable fuses of the knife-blade type which make these fuses exceptionally simple in design and construction.

The illustration shows the details of design and construction. When the fuse is taken apart for renewal of



Details of the Newly Designed Renewable Fuse

the fusible element, there are only three loose parts—the fiber case to which the threaded brass ends are securely attached; the knife-blades which are connected by a rigid fiber bar and to which the fusible element is bolted; and one of the loose screw caps which hold the knife-blade member in position.

All that is necessary to disassemble the fuse is to unscrew the two caps, and then slip out the entire knife-blade member after one end of it has been shifted slightly to get it out of its locked position. One of the caps can be removed, but the other is held on the knife blade by two nips. Assembly is accomplished just as readily.

Extra heavy grey horn fibre is used in the construction of the case so that it will withstand the pressure developed by the blowing of the fusible element. The brass ends are securely attached to the fibre, and venting, which is an important feature of fuse operation, is accomplished by means of a number of grooves cut longitudinally in the fibre where attachment is made to the brass ends. After the ends are put on, these grooves become ducts which are large enough and of sufficient number to permit the escape of the gases caused by the volatilization of the fusible element and to relieve the case of the pressure generated; yet they are small enough so that the flame is effectually quenched before it reaches the outside. Also, these vents prevent molten metal from getting into the threads of the caps and causing them to stick and make removal difficult.

It also will be noted that the simplified design gives large openings in both casing ends, thus making it easy to inspect or clean the inside.

The knife-blade member, to which the fusible element is attached, consists essentially of two sections of flat copper which are connected by a rigid fibre bar. These connections are made by means of rivets and screws. The assembly is rigid and the copper blades are positively held in position and alignment, assuring permanent contact with the clips. The connecting bar, which is attached by means of screws, may be readily replaced in the event of damage or breakage.

The fusible element makes direct contact with both knife-blades and is held down at each end by a stud and washer. When making renewal these studs need to be loosened only slightly, and the fusible element, which is notched at both ends, can be slipped in the studs tightened; there are no through bolts, with heads that have to be held or nuts that can be lost or misplaced. The design of the fusible element is an exclusive feature of "Union" renewable fuses, which blow without violence or flash, fusion occurring midway between contacts so that the metal parts are always clean.

These new fuses will be fully approved by the Underwriters and are made in all standard ratings—from 65 to 600 amperes, 250 or 600 volts.

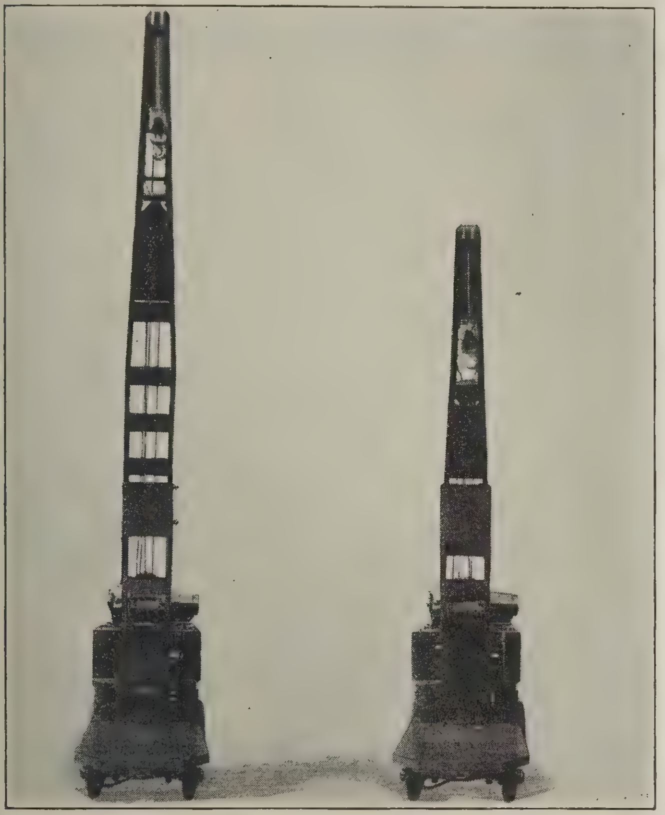
Crane with Telescoping Boom

The Elwell-Parker Electric Company, Cleveland, has added a telescoping boom to its Type CK portable electric crane. An especially long boom is at times a hindrance rather than a help, while with a short one there are frequent calls for a lift beyond the boom range. To meet this situation a telescoping boom with four settings between 12 and 17 ft. is now offered. The boom is all steel and is raised or lowered by a special set of cables operated from an electric motor-driven hoist unit with two grooved drums. The second drum carries a separate ⅜-in. plow steel non-twist cable to a two-part line hook block sheave on the boom tip.

The heavy boom side channels are latticed and gusseted with a continuous ¼ in. steel plate extending above from the hoist cable sheave to the boom elevating sheave, i. e., throughout the length of the curved head of the boom. The lower box or enveloping section of the boom is of

formed plate steel, providing a stout support for the telescoping portion. A feature of this boom is that the distance from the top of the boom to the hook is but 23 in.

The battery compartment carrying the hoist unit counterbalances the boom with a load on a steel crane column

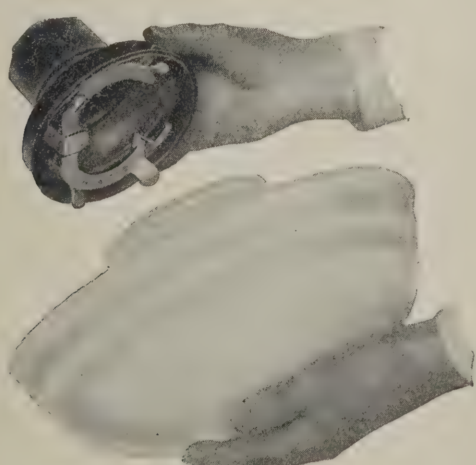


The Crane with Boom Elevated and Lowered

supported on ball and roller bearings. This column is set in a heavy pedestal firmly anchored in the main frame. The boom may be furnished with a hand or motor slew.

Security Safety Holder

The Central Electric Company, Chicago, has recently brought out a new addition to its regular line of Attalite Commercial Luminaries in the form of a new security



Method of Assembly

screwless holder. The device assures the proper position of the enclosed globe and eliminates the possibility of broken glassware.

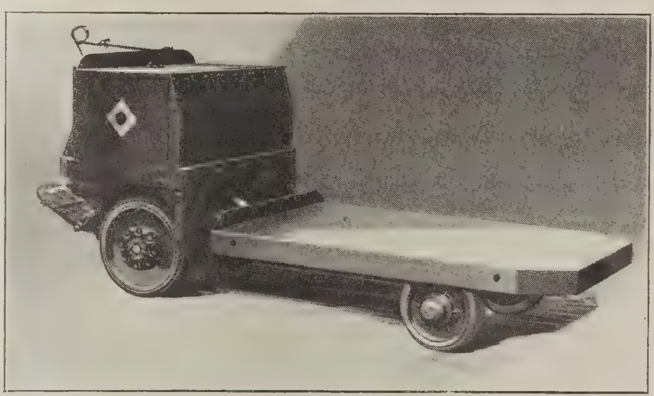
The expeditious assembly of globe and holder is an important factor in maintenance costs, especially in large installations.

The device has been tested in a laboratory and is claimed to be fool-proof and a great labor saver. It can be applied to any Attalite center or pendant luminaires.

Large Capacity Electric Lift Tractor

The success of the electric lift tractor within buildings has tempted many users to increase the range of this type to more distant points on the premises where runways are in poor condition. In most instances this has required the extension of runways, although some concerns have not given proper values to such improvements. On the other hand, yards and storage spaces often are so extensive that the laying of ideal trucking surfaces would possibly require a prohibitive investment.

The improvement of the trucking device has kept pace with the encouraging interest taken by the average user in its employment. The Elwell-Parker Electric Company, Cleveland, Ohio, has developed a heavier unit of the electric lift-type especially suited to travel runways not altogether smooth. This haulage unit is of broader gage than those designed particularly for inside operation. The gage of the front and rear wheels is the same, i.e., 30 in.



Electric Lift Tractor Specially Suited to Travel Over Uneven Runways

They are fitted with 22 in. drive and 15 in. front wheels and with either 3½ in. or 4½ in. tread. The drive wheels are equipped with double row ball bearings weighing 13 lb. each, and radial and thrust bearings measuring 7 in. in the outside diameter.

These wheels are carried on drop forged knuckles with drop forged levers pressed on tapered serrations, assuring a firm union of the two. These knuckles support the weight of the axle, frame and load on a steel ball bearing recessed in a cup at the upper ends. The levers are fitted with ball ends received in the steering rod sockets. All the rods are placed high beneath the platform to avoid contact with obstructions on runways. The full-floating, alloy steel, drive shafts are pressed into drop forged clutch plates bolted to the outside of the drive wheels, these shafts being fitted with chrome-vanadium universal joints and engaging the splines of the differential.

The low set, all-steel battery compartment at one end is fitted with removable end doors and a hinged cover to facilitate inspection. The wire leads between the controller and the battery are continuous—no splices—to the motor brush studs and the motor field coils.

General News Section

The Piedmont & Northern is reported to be planning an extension from Charlotte, N. C., to Winston-Salem, about 75 miles.

The Chicago Fuse Company, Chicago, Ill., announces the removal of its Philadelphia office from the Weightman building to 517 Packard building.

The Erie has petitioned the Interstate Commerce Commission for a further extension of time until January 1, 1926, in which to complete the train control installation ordered by the commission.

The Pacific Electric is contemplating the construction of an extension from Arrowhead Springs, Cal., to Lake Arrowhead in San Bernardino. The cost of the project is estimated to be about $800,000.

The Strom Ball Bearing Manufacturing Company, Chicago, announces the appointment of Frank R. Schubert as general manager. John Dlesk succeeds Mr. Schubert as works manager and Lorenz Peterson continues as assistant works manager in charge of production.

The Boston & Albany and the Pittsburgh & Lake Erie have asked the Interstate Commerce Commission for relief from the commission's automatic train control order until the result of operation of installations on other parts of the New York Central system have been determined.

The Gibb Welding Machines Company (successors to Gibb Instrument Company) of Bay City, Michigan, manufacturers of electric welding equipment, announce the appointment of Arthur Jackson, 32 Glenholme Avenue, Toronto, Ontario, as sales representative for Ontario and Eastern Canada.

The General Electric Company, according to an announcement of its president, Gerard Swope, will retire, on September 1, the entire outstanding issue of its 5 per cent gold debenture bonds of 1912, due September 1, 1952, and amounting to $15,136,500, at 107½ per cent of the principal amount of such bonds and accrued interest.

The Kuhlman Electric Company, Bay City, Michigan, has appointed the Stevens Sales Company of 134 West Second South Street, Salt Lake City, Utah, as district representative for the state of Utah and parts of Idaho and Nevada, adjacent to Utah. The Stevens Sales Company will handle Kuhlman power, distribution and street lighting transformers.

In order to reduce the fire hazard, the Denver & Salt Lake is equipping some of its section crews with fire fighting equipment and is having them follow all trains over their sections of the line where there is danger of forest fires being started from sparks from the locomotive. The danger of forest fires is particularly acute at the present time on account of a long drought.

Lincoln Electric Company, Cleveland, has announced the establishment as distributors of Lincoln motors and welders in the state of Georgia, the firm of Whitman and Brandt, Atlanta, Ga., who will represent the Cleveland manufacturers through that entire territory. The appointment follows the announcement of the Clyde Equipment Company as distributors for Lincoln products in the states of Washington, Oregon and Idaho.

A series of slight earthquakes, following the more severe ones which blocked the lines of the Northern Pacific and the Chicago, Milwaukee & St. Paul in the vicinity of Lombard, Mont., in June, have caused a number of minor landsides which have encroached upon the railway. By working a steam shovel 24 hours a day, the St. Paul has just completed the cleaning up of its line. The line has been kept open for trains at all times except for a few days following the severe earthquakes.

The total number of persons killed at highway grade crossings in the United States in the first three months of this year was 419, as compared with 464 a year ago; and of injured 1,208 as compared with 1,504. This item is the subject of a circular which has been issued by H. A. Rowe, committee chairman, on behalf of the Safety Section, A. R. A. Mr. Rowe says that the public is taking an increasing interest in the work of his committee, and he calls upon all the members to "make vigorous use of this wonderfully encouraging report."

Passenger traffic out of Chicago on July 2, 3 and 4 for the holidays exceeded that of last year by over 20 per cent. On the Chicago & North Western the holiday traffic on July 3 and 4 established a new high record. The increased volume of business was brought about by special rates of a fare and one-third for the round trip to all stations where the regular one-way fare is $7 or less. The Chicago, Rock Island & Pacific reported an increase of 20 per cent in its holiday traffic over that of last year. The New York Central operated ten extra sections on its through trains on July 2.

Westinghouse Electric of Japan Organized

To distribute Westinghouse products throughout Japan, the Westinghouse Electric Company of Japan has been organized. The officers of the new company, which is a subsidiary of the Westinghouse Electric International Company, are: Guy E. Tripp, chairman; L. A. Osborne, president; E. D. Kilburn, vice president; and I. F. Baker, managing director, located at Tokyo.

Following the organization meeting of the new company E. D. Kilburn, vice-president, made the following statement:

"The Westinghouse Electric Company of Japan is a newly organized subsidiary of the Westinghouse Electric International Company, incorporated under the laws of

the state of Delaware, with a capital of $1,000,000. The purposes of this company are to distribute Westinghouse products throughout Japan and to arrange for proper service to the many old as well as the new users of Westinghouse apparatus in Japan. Adequate stocks will be carried, repair and other service facilities will be provided and engineering and construction assistance will be supplied to users of the company's products. The staff in Japan will be almost entirely Japanese. It was a simple matter to assemble this staff because there are scores of Japanese engineers who have been employed at the Westinghouse Company Works of East Pittsburgh and elsewhere."

New York's Suburban Transit Plans

Members of the New York Suburban Transit Commission and the North Jersey Transit Commission, both of which are making plans for the development of rapid transit communication between New York City and the outlying suburban districts, met jointly in New York on July 9 to co-ordinate their plans. These plans provide for a loop subway intersecting all the New Jersey railways and running from the Battery in Manhattan, northward to about Fifty-seventh street with tunnels under the Hudson river at either extremity connecting with New Jersey. Another new subway would be constructed on the east side of Manhattan Island which would cross under the East river to Brooklyn and extend to Jamaica, Queens. Still another line would extend from the Battery, northward to 149th street, the Bronx, which would give a connection for suburban trains of the New York Central, New York, New Haven & Hartford and the New York, Westchester & Boston. The plans provide for the operation of the railroads' suburban trains in these subways. The total project would cost approximately $680,000,000.

Flood Damages Colorado Roads

Railroads in the vicinity of Trinidad, Colo., were considerably damaged by a flood which developed following a series of cloud-bursts on July 22. One span of the Atchison, Topeka & Santa Fe bridge at Jansen, Colo., three miles west of Trinidad, was washed out, as was a part of the Trinidad yard. The passenger station and the Fred Harvey hotel were surrounded by water. The Denver & Rio Grande Western lost one of its bridges and several hundred feet of track in Trinidad. Two bridges of the Colorado & Wyoming, a subsidiary of the Colorado Fuel & Iron Company, were also destroyed. Many trains were delayed by the storm and the damage to the tracks.

Further Extensions of Time for Train Control Installation

The Interstate Commerce Commission has granted further extensions of time, on petitions filed by the railroads, for the fulfilment of its order of June 13, 1922, requiring the installation of automatic train control. The date originally set was January 1, 1925, but the commission in most instances granted extensions to July 1. It has now extended the time to January 1, 1926, for the New York, Chicago & St. Louis and the Louisville & Nashville, to October 31, 1925, for the Atlantic Coast Line, and to July 1, 1926, for the Chicago, Indianapolis & Louisville.

On petition of the Kansas City Southern for relief from compliance with the two train control orders of June 13, 1922, and January 14, 1924, the commission has suspended the effective date of the second order in so far as it applies to this company and has postponed the effective date of the first order from July 1, 1925, to July 1, 1926.

A hearing on the application of the Great Northern for relief from the second order was held at Washington on July 13 before Examiner Mullen.

Chicago Union Station Dedicated

The new Union Station at Chicago was formally opened to the public and dedicated to its service on July 23 when Samuel Rea, president of the Pennsylvania, and also of the Chicago Union Station Company, Hale Holden, president of the Chicago, Burlington & Quincy, H. E. Byram, receiver of the Chicago, Milwaukee & St. Paul, and J. D'Esposito, chief engineer in charge of the construction of the terminal, held a reception for officers of the city, executives of other railways entering Chicago, and members of the Illinois Commerce Commission. Following a tour of inspection of the station, a lunchen was tendered the visitors.

Pennsylvania Places Orders for Passenger Equipment to Cost $6,000,000

The Pennsylvania has placed orders for 357 passenger cars of all steel construction, to be delivered as soon as equipment companies can complete their construction. The orders call for 222 baggage cars, 105 passenger coaches, 15 combination passenger and baggage cars, 10 combination baggage and mail cars and 5 combination passenger, baggage and mail cars. The estimated cost of this equipment is $6.000,000.

Excursions with Stop-Over Privileges Adopted to Increase Traffic

The Norfolk & Western, the Baltimore & Ohio, and the Pennsylvania have announced a series of tourist excursions from Columbus, Ohio, on stipulated dates on regular trains with 16-day stop-over privileges which will be run in addition to the one-day excursions which have been put into effect recently. The Norfolk & Western will run excursions to Norfolk, Va., on August 16, with special rates for the trip and stop-overs at any point along the way. The Baltimore & Ohio operated excursions to Atlantic City on July 13 and August 3, with stop-overs with 16-day return limits at Philadelphia, Baltimore, and Washington. On the same dates this company also ran low fare tourist excursions to Cape May, N. J., Wildwood, Sea Isle City and Ocean City. The Pennsylvania operated low fare tourist excursions to Atlantic City on July 29 and August 12.

Unveiling of Memorial Tablet on Alfred H. Smith Memorial Bridge

On July 14 a tablet in memory of the late Alfred H. Smith, president of the New York Central, was unveiled on the Alfred H. Smith Memorial Bridge over the Hudson river at Castleton, N. Y. The building of the bridge and the Castleton cut-off were begun by President Smith and the bridge was named in memory of him. President

P. E. Crowley, of the New York Central, opened the unveiling ceremonies. He was followed by C. C. Paulding, assistant vice-president, and the Rev. Dr. F. N. Clendenin. Miss Charlotte Smith, granddaughter of President Smith, unveiled the tablet.

Rouyn Gold Fields to Have Railway Soon

Many conferences with the Quebec government have been held in the last few weeks by the various railways desiring to get permission to build lines into the Rouyn goldfields, and following one conference last week Premier L. A. Taschereau announced at Quebec City that he had received a personal letter from Sir Henry Thornton, president of the Canadian National, in regard to the Rouyn Mines Railway and that he, Premier Tashereau, could assure the mining region that it would have a railway within a few months. It is known that a charter has been granted by the Quebec government to the Rouyn Mines Railway which is to be built with United States money and to be leased by the Canadian National.

While the question of the power of the federal government to give the Nipissing Central, an Ontario Government-owned road, a permit to build over Crown lands eastward from Ontario into Rouyn is before the Supreme Court of Canada, Ontario officials refuse to say much about their project, although Charles McCrea, Minister of Mines for Ontario, when asked about Sir Henry Thornton's plan to build a road from O'Brien down to Rouyn (O'Brien is on the National Transcontinental) said, "My only comment is that transportation into the Rouyn gold field should be provided without delay in the interests of Canadian mining development."

There is also talk of the Canadian Pacific still pressing for a chance to build into Rouyn from Angliers. There is no figure mentioned as a possible grant for extending the C. P. R. line from Angliers, but it is stated that by extending its line toward North Bay, after going through the gold fields, the traffic would be sufficient to warrant the expenditure involved.

Flashing Light Signals at Highway Crossings in Pennsylvania

The Public Service Commission of Pensylvania has issued a circular announcing its approval of the action of the Department of Highways, of that State, in prescribing rules for the installation of lights on the highways approaching grade crossings of railroads.

The agreement, covering these rules, which is between the Department of Highways and "such steam railroad companies as may become parties to it," applies only to the "primary system" of state highways. The crossings are divided into two classes (1) where the traffic on the highway is such that automobiles may conveniently be stopped and (2) where stopping would cause congestion. For the first class the state is to erect stop signs, one on each side of the railroad, equipped with two horizontally arranged flashing lights, flashing together, not alternately. The railroad bears half of the cost of installation and the state the other half; and the Department of Highways will operate and maintain.

At the second class of crossings, the railroad is to erect the signal, which is to conform to the A. R. A. standard. It must be a wig-wag or alternately-flashing red lights, arranged horizontally, the signal to be actuated by the approach of a train. The first cost is to be divided as stated above, but the railroad is to operate and maintain.

The agreement prescribes details of installation. It calls for an additional cautionary yellow flashing light where the principal signal can not be seen 500 ft.

Paris-Orleans Electrification

Lines to be operated wholly by electricity are approaching completion. These are largely of suburban or interurban classification, the long stretches over which it proposed to run the Franco-Spanish international expresses being relegated into a more remote future. The company has erected a locomotive shop at Vitry-sur-Seine in suburban Paris for the equipment and repair of its electric locomotives already in service on the Austerlitz-Juvisy and Bretigny-Dourdan lines and a new section, Bretigny-Juvisy, is soon to have its power from a new substation.

During the past year the company has received ten electric locomotives, three electric motor cars, 34 passenger cars and nine freight cars for its electric lines. Delivery is expected on 195 electric locomotives, 77 electric motor cars and 76 trailers.

Pullman Company Names Car for Porter Hero

The Pullman Company has named one of its cars after Oscar J. Daniels, a porter, who lost his life in the derailment on June 16 on the Delaware, Lackawanna & Western of an excursion train from Chicago to New York, near Hackettstown, N. J. In consideration of valorous work in rescuing and attending the injured, a conductor and three porters of the Pullman Company were given stock by the company. The car in which Daniels rode at the time of the wreck lodged alongside the locomotive in such a manner that steam escaping from the locomotive entered the car through a door which was thrown open. In order to save the passengers, Daniels worked his way through the steam to the door and closed it.

D. T. & I. Employee-Investors Receive 16 Per Cent Interest

For the second successive six-month period, the Detroit, Toledo & Ironton savings certificates, of which the employees own $352,000 worth, will bear 8 per cent interest, making the yearly return on the basis of 16 per cent.

Trade Publications

Crouse-Hinds Company, Syracuse, N. Y., has just issued an illustrated folder showing various types of screw covered junction condulets.

The General Electric Company, Schenectady, N. Y., has just issued its bulletin No. 47703-C describing and illustrating panel and bench board pipe fittings. The bulletin contains many tables giving complete information about each fitting.

The Westinghouse Electric & Manufacturing Company has recently issued an illustrated booklet describing arc welded buildings. The booklet shows how the Chicago, Burlington & Quincy has successfully constructed structural steel buildings entirely by arc welding, securing thereby stronger joints at lower cost.

Railway Electrical Engineer

Volume 16 SEPTEMBER, 1925 No. 9

The October Convention

The 1925 Annual Convention of the Association of Railway Electrical Engineers will be held in the Hotel Sherman at Chicago, October 26 to 30. This event will unmistakably mark a decided step forward in the history of the association. The organization has been gradually growing in membersip for more than a decade, but the feature which makes it necessary to find new quarters to house the convention is not alone the increase in attendance, but the ever increasing number of railway electrical supply manufacturers who furnish their annual exhibit at this time.

In the Hotel Sherman's recently constructed hall, there will be provided more extensive housing facilities for the large number of exhibits which are always so interesting to the electrical men who attend the convention. Each succeeding year seems to bring additional exhibitors into the ranks of the supply manufacturers' association, so that the exhibition hall is a center of attraction at the convention. That this should be so is most logical as there is probably no other opportunity where railway men are able to see collectively and to examine with leisure so formidable an array of the various kinds of electrical equipment used on the railways. If there were no convention at all and only the exhibit, it would be well worth while for every electrical man to visit these exhibits and benefit by the unusual educational opportunity provided.

On the other hand it is doubtful if exhibits alone would bring the electrical men together from all corners of the country. It is the convention and convention spirit that does this. Electrical men are interested in electrical machinery, beyond a doubt, but they are also vitally interested in learning just what the other fellow is doing and how successful he is in meeting the problems that are constantly arising in the daily routine of work. Convention reports and discussions are of utmost importance and will produce no end of good. In short, the thing that puts the convention of the Association of Railway Electrical Engineers over with a bang is as Kipling says "the everlasting team work of every bloomin' soul." No man ever attended one of these conventions without coming away with ideas which he eventually put into practice and which eventually saved money for the company that he represents. You cannot afford to stay away from the convention this year. If you are going to keep up with the times you must be on hand to find out what the other fellows are doing and to see for yourself the latest devices which the manufacturers have to display for your edification.

High Standards In Welding

No more valuable tools than the welding electrode and torch have ever been placed in the hands of railroad workers. Economies and saving of labor which were previously unthought of have been made possible. The art has progressed so rapidly, however, that it has been necessary to lay down rules restricting its use. A number of these rules circumscribe the possibilities of welding and limit its use. They were laid down because welding work is not uniformly well done.

With trained operators, effective supervision and outlined procedure for making welds, the possibilities of welding are almost unlimited. Keeping a check on quality of work done by a given operator is also of equal importance. Carelessness or laxness of operators is checked on the Santa Fe by the use of a monthly test which is described elsewhere in this issue in an article entitled "Welding in Railroad Shop Practice." The article describes Santa Fe practices particularly as they are applied to the shops, at Albuquerque, New Mexico. Welding has been brought to a high state of development on this road and as they have been the result of much independent work, the practices described will probably be of interest to many other roads.

Your Personal Slogan

Many subjects have been touched upon in the pages of the *Railway Electrical Engineer* in the past and most of them have been of a helpful nature to the majority of our readers. In a technical magazine such as this, it is expected that technical matters will be presented for consideration and other subjects therefore do not always find space even though they be of greatest importance.

There is one subject which although it cannot be considered as technical is of vital interest to every reader of this fagazine, and that is the subject of personal safety.

This question of safety is one which has been given greater consideration during the past decade than ever before and in some respects is especially significant to electrical workers. Danger from electrical circuits is invariably unseen danger and any carelessness in handling of electrical conductors or apparatus should not be permitted under any circumstances. There is nothing truer than the expression that "familiarity breeds contempt" and this applies with special emphasis to many workers around electrical equipment. The slightest false movement made in the vicinity of a high voltage line may re-

sult in a most disastrous accident. Men who are continually working about such equipment are thoroughly familiar with this fact and yet some of them are indifferent to the point of recklessness.

Nor is all of the danger confined to the high voltage lines by any means. Short circuits on heavily loaded, 110 volt feeders may result in the most distressing catastrophe. Deep infected burns from molten copper and even loss of eyesight may result from short circuits on low voltage lines of large capacity.

Personal safety is not a matter to be dismissed lightly. The worker who continues to ignore all precautions possesses the wrong mental attitude for his work and is an actual menace to those who are obliged to work with him. "Safety first" is a good slogan and we cannot have too much of it.

Motor-Generator Locomotives

The motor-generator locomotive recently completed by the Detroit, Toledo & Ironton is in many ways an innovation in the motive power field. The outstanding advantage of this type of locomotive is its ability to use series d. c. traction motors and at the same time receive power from a high voltage a. c. trolley. This means a minimum of transmission losses and the number of substations necessary, an increase in the economical range of power, a light line and trolley construction, small return ground currents and with the use of synchronous motors in the motor-generator sets the power factor may be kept at unity under all conditions of load. The type of drive used is unique and permits all of the weight of the locomotive to be placed on the drivers. When the locomotive was taken from the shops to the D. T. & I. tracks, curves as high as 16 degrees were negotiated without difficulty. The direct current motors are designed to receive power from a generator with definite characteristics and this permits improvements in motor design which are not possible when the motor is to receive power from fixed d. c. substations located along the right-of-way. A feature of the motor-generator voltage control is the wide range and great flexibility of both motoring and regenerating periods combined with a minimum of rheostatic losses. All direct current circuits are ungrounded and closed within the locomotive thereby reducing to a minimum resistance losses and electrolysis due to ground currents.

Seven more locomotives of this general type are now in process of construction for the New York, New Haven & Hartford. The mechanical design of these locomotives will follow established designs more closely than is the case with the D. T. & I. locomotive, but the fundamental feature will be the same and they will also be equipped with motor-generator sets.

It is difficult to anticipate what effect these locomotives may have on future designs. So far as electrical operation is concerned they are practically ideal, for they combine the desirable features of the high voltage a. c. trolley and the equally desirable features of the d. c. series traction motor with a minimum of resistance losses. The undesirable characteristic of these locomotives is that each set of motors must be supplied by a substation of sufficient size to supply the maximum demand of the motors and this substation must be carried on the locomotive. When the substations are located along the right-of-way the load is diversified and the total substation capacity does not need to be as great as the connected motor or locomotive load. Furthermore, the motor-generator locomovtie is expensive as compared with other types, and the price of electric locomotives is already so high that it is an effective damper to railroads considering electrification.

Marked developments in stationary substations or in traction motors may eliminate the need for the motor-generator locomotive, but it is also quite possible that this type of motive power will prove to be more desirable than any other for meeting all service conditions. The locomotive suggests a possible standardizing of electric locomotives; a desirable end even if the cost is considerable. It suggests that, having adopted the admittedly desirable feature of the high voltage trolley and the d. c. traction motor, let future development work be concentrated upon portable conversion apparatus. Certainly standardization and increased production of electric locomotives would reduce unit costs. The D. T. & I. and the New Haven should be given credit for opening up these possibilities.

Railroad Power Plants

Railroad power plants probably offer as great an opportunity for saving money as any other railroad facility. In many cases they are regarded by those who used them as just a building from which comes steam, water, air and electric power as required by the terminal. Just what is the reason for this apparent apathy is problematical. It may be lack of funds for making improvements, it may be fault of organization or jealousy between departments, or it may be just habit.

During the past four years, the central station industry has increased the efficiency of its plants 35 per cent. It is a certainty that no such improvement has been made with railroad power plants. When a real effort is made to make such an improvement the result is astounding. An article published in this issue tells how the St. Paul has made an improvement to a single plant with a resultant saving of $70,000 per year. Similar examples can be sighted on a few other railroads, but they are the exceptions rather than the rule. In the power plants lies an opportunity for some engineer on the railroad to make a reputation for himself.

New Books

Power Station Operation. Volume 1. 100 Pages, illustrations and diagrams, 5½ in. x 8½ in. Bound in paper, published by Electrical Times, Ltd., Sardinia House, Kingsway, London, WC 2. Price $0.87.

The book is arranged as a series of questions and answers. There are 260 of these treating on all of the more important problems which are encountered in power plant operation. The subject matter is divided into nine sections, and the questions and answers cover the following: The boiler and steam raising turbine, alternators, generating sets, condensers, pumps, ejectors, transformers, rotaries, and motors, switch and control gear, means of grounding and balancing, testing and measuring for oil treatment. In short the book contains a wealth of information to those interested in power station operation.

The Brown-Boveri Car Lighting System

Small Regulator of Unique Type Controls Both Lamp Voltage and Battery Current

THE train lighting system and its component equipment which is described in this article, is extensively used in Europe and approaches the standard for such equipment in the countries of Switzerland, France and Russia. It is a system which is applied to a passenger coach and is independent of adjacent cars in the makeup of the train, being a complete system for each coach. A constant voltage is applied to the lighting circuits and a varying voltage conforming to the charging characteristics of the battery is applied to the battery when the generator is in operation. This is accomplished by the use of a single regulator of a simple design and small dimensions. This regulator primarily assures the prescribed foot-candle intensity in the coaches by the regulation of the generator voltage during the running period, and also governs the voltage and current characteristics of the charging rate of the battery in accordance with the approved charging characteristics of the type of battery used. This latter feature is one of the features of this system. It is claimed to permit the use of a smaller battery and to maintain a battery life in excess of that usually found possible with either the constant voltage or the constant current systems of battery charging.

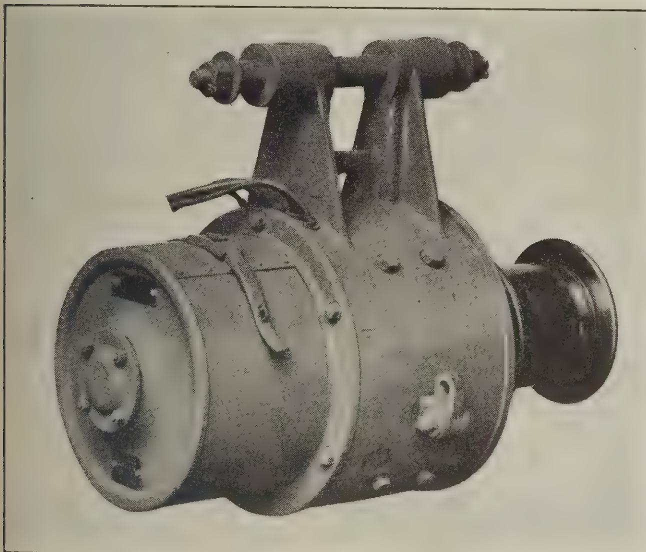


Fig. 1. The Generator is a Standard D. C. Shunt Machine

Generator

The d. c. generator (see Fig. 1) is of the variable speed type. It is a standard machine with four poles, shunt-wound and of simple and sturdy construction without any special auxiliary windings or brushes. Two brackets (cast onto the stator) carry the suspension pin and are used to bolt the machine either to the under frame of the coach or to the truck (see Figures 2 and 3). The generator has ball bearings of simple design which allow for dismantling and reassembling without difficulty. These ball bearings are designed for grease lubrication, the containers being amply dimensioned and large enough to hold a sufficient supply of grease for twelve months' service. The friction of the brushes on the commutator controls the brush rocker which brings the brushes into the correct position for either direction of rotation and assures correct polarity regardless of the direction of rotation. The complete machine is dust proof and water tight. A tight fitting sheet iron cover, easily removable, allows for inspection of the brushes.

Novel Automatic Voltage Regulator Used

The automatic regulation of the current and voltage is taken care of by one piece of apparatus (see Fig. 4). This comprises the voltage limiting device, the paralleling switch, the lighting current relay and the solenoid system with contacts and resistances. The automatic regulator weighs only 29 lbs. and little space is needed for mounting so that it can be accommodated easily in any remote corner of the coach. The moving parts are few and are arranged on an aluminum plate which permits them being inspected easily. The fixed parts of the regulator are mounted behind this plate, these being the resistance and relay coils. To avoid accidental breakage, special attention has been paid to the protection of the resistance coils. A sheet iron cover is provided to prevent the apparatus from being tampered with unnecessarily or damaged accidentally. No part of the apparatus needs lubrication and no mercury contacts are used. All the terminals are marked and allow for easy connection to the circuit.

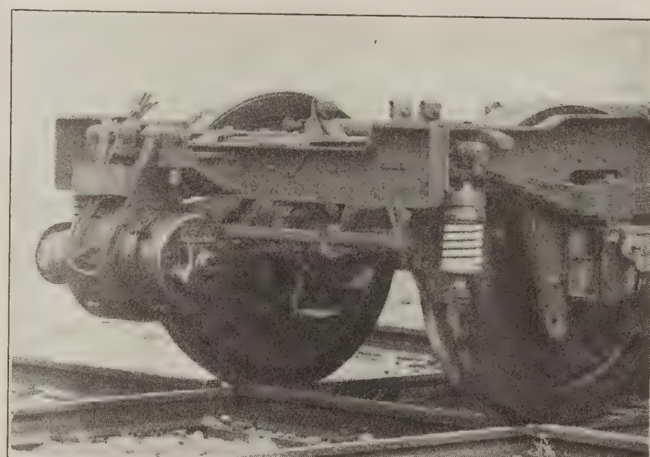


Fig. 2. Method of Truck Suspension Used in Many European Countries

The generator voltage is regulated by increasing or decreasing the resistance in the shunt circuit which is an integral part of the device. The various resistance steps are connected with a row of contacts arranged in the form of an arc of a circle and are short circuited by a flexible metal band when the apparatus is not in operation. This band is supported by a movable iron core set vertically into motion when the solenoid M (see wiring diagram Fig. 5) is energized, the metal band being lifted off the contacts, thus inserting or cutting out more or less resistance, according to the requirements. When the genera-

tor speed increases, the pull of the voltage magnet overbalances that of the mechanical spring *F*, thus shifting the ends of the metal band and inserting more or less resistance steps into the shunt circuit.

Operation of Regulator Under Different Conditions

To visualize accurately the operation of this regulator, two specific operations are described below. In the first, the lights are out and the storage battery partly discharged, and in the second, the lights are on and the storage battery partly discharged. Both operations are described by means of the diagram of connections in Fig. 5.

As soon as the train is set in motion, the dynamo armature, driven from the car axle, begins to rotate. The number of revolutions increases in proportion to the speed of the train. The shunt field circuit remains connected direct to the positive pole of the dynamo through the metal band of the regulator, so that the machine is excited even at a low train speed. A certain current flows through voltage coil *P1*, which is connected to the two terminals of the dynamo. The magnet *P* is designed to attract the armature *C* at the moment when the terminal pressure is equal to the battery pressure. The dynamo is thus connected in parallel with the battery without any appreciable flow of current or sparking.

As the train speed increases, the dynamo voltage also continues to rise. Hence, current flows into the storage battery through current coils *P2*, *M2* and *U2*. At the same time a current corresponding to the resistance of the shunt circuit flows through the voltage coil *M1*. The magnetic field of solenoid *M* exercises a certain pull upon the solenoid core, which is kept in position by the counter action of the spring *F*. If the train runs faster, the

Fig. 3. A Body Hung Generator

magnetic field of the solenoid *M* is also increased, the force exerted on the core now becomes stronger than the tension of the spring, and the iron core is caused to move along its axis. The solenoid core, when moving upwards, lifts the metal band lying over the whole of the contact path, this causing the first resistance steps to be inserted into the shunt circuit. The voltage applied to the terminals of the battery now corresponds to its state of charge. At a higher train speed the strengthened magnetic field will lift the metal band still further off the contact path, causing further resistance steps to be inserted, so that the generator voltage is prevented from rising any higher. If, on the contrary, the train speed decreases, the magnetic field of the solenoid *M* becomes weaker and the iron core moves in such a way as to cut out resistances so that the terminal voltage does not drop. The adjustment of the metal band is effected so rapidly and accurately under the influence of the solenoid, that the generator voltage remains practically constant at all train speeds. Charging of the storage battery, therefore, takes place independently of the train speed. As charging of the battery proceeds, the internal resistance of the battery slowly increases, the charging voltage rises gradually and the charging current is reduced accordingly. The ability to charge with a high initial current at a low voltage, and the

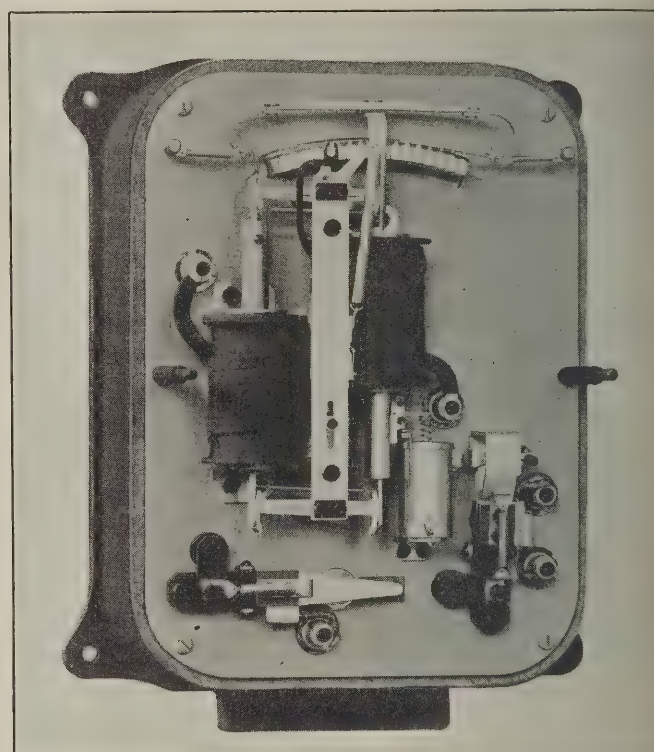


Fig. 4. Automatic Regulator for Controlling Charging Rate of Battery and Lamp Voltage

gradual changing over to a smaller current and higher voltage towards the end of the charging period, is of the utmost importance and accounts partly for the attention which this equipment has received in Europe. Proof is given in statistics regarding the life of some thousands of train lighting batteries working in conjunction with this equipment which show that an average life of 10 years or more is reached.

When the battery voltage at the end of charging has reached about 2.5 volts per cell, relay *U* attracts the armature *A*, so that a resistance is connected in parallel with the circuit of coil *U1*. The pull of the solenoid core is now increased on account of the strengthened magnetic field of coil *M1* and resistance is inserted into the shunt circuit until the terminal voltage is equal to the open-circuit voltage of the battery (about 2 volts per cell), so that current can flow neither into nor out of the battery. Special protection is provided so that the charging voltage relay does not respond prematurely in the event of current surges, or sudden application of the brakes, thus preventing the battery from being charged any further. For this purpose

the current coil U_2 is employed, the action of which is opposed to that of coil U_1.

The above refers only to operation with lights switched off. If the lights should happen to be switched on, the magnetic field of the solenoid U is strengthened by the coil U_3, through which the lighting current passes. This causes the switch A with contacts *2* and *3* to close and at the same time causes contact *1* to open again. As a consequence, the dynamo voltage will be increased by about 10 per cent so that the dynamo again generates current.

The curves shown in Fig. 6 are the result of a series of tests carried out with a similar type of regulator by a

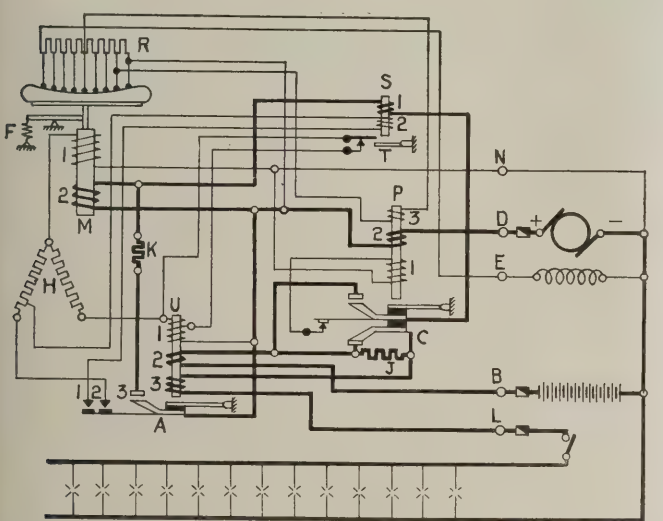


Fig. 5. Wiring Diagram of Connections of Complete Car Lighting Installation. M—Windings of regulator. H—Auxiliary resistance. K—Diverting resistance. U—Windings of charging voltage limiting device. C—Paralleling switch. J—Auxiliary resistance for light circuit. P—Windings of paralleling switch. S—Windings of desulphating relay. R—Excitation regulating resistance. F—Main spring. A—Voltage limiting device. T—Desulphating relay.

United States manufacturers of train lighting equipment. The operation referred to is that of a battery being fully charged with a lamp load of 6.3 amperes. It will be seen that the voltage curves of both the generator and the light circuit are practically straight lines (curves 1 and 2). The battery used in connection with this test was a lead type, 18-cell, 150 ampere-hour battery.

Operation With Lamps Connected

When the train stops the lamps are fed by the storage battery. If the train begins to move, the connection of the dyanmo in parallel with the storage battery again takes place at the moment when the generator voltage is equal to the open-circuit voltage of the battery. This switching in produces no appreciable sudden change in the intensity of the light. The magnet of the solenoid coil M begins to operate, effecting the regulation of the shunt current. The resulting dynamo current flows through solenoid coil P_2, across the switch A of the lighting current relay U and relay coil S_1, across the main switch C, through solenoid coil U_2, and into the battery. From this point part of the current flows across resistance J and solenoid coil U_3 to the lamps. Resistance J prevents the lamps being exposed to the higher charging current. In addition to the lighting current, the dynamo supplies a certain amount of charging current to the storage battery.

The relay switch A with contacts *2* and *3* is kept closed under the influence of the solenoid coil U_3, through which the lighting current flows (contact *1* still remains open). From the diagram of connections in Fig. 5, it is evident that contact *2* when closed connects in parallel the two halves of the series resistance H and that the solenoid coil M_2 is switched straight across resistance K by the closed contact *3*. As a consequence of the paralleling of the resistance H, an increased current corresponding to the reduction in resistance flows through coil M_1 and strengthens the magnetic field of the solenoid. The core lifts the metal band further off the contact path and inserts a certain resistance into the shunt field circuit, which reduces the terminal pressure of the generator to a determined value, corresponding to about 2.3 volts per battery cell. With a constant lighting current this voltage, which is required for the full utilization of the dynamo, is always maintained independently of the varying train speed. During the journey the lamp voltage is subject, within narrow limits, to variations which are dependent upon the state of charge of the battery. The maximum difference

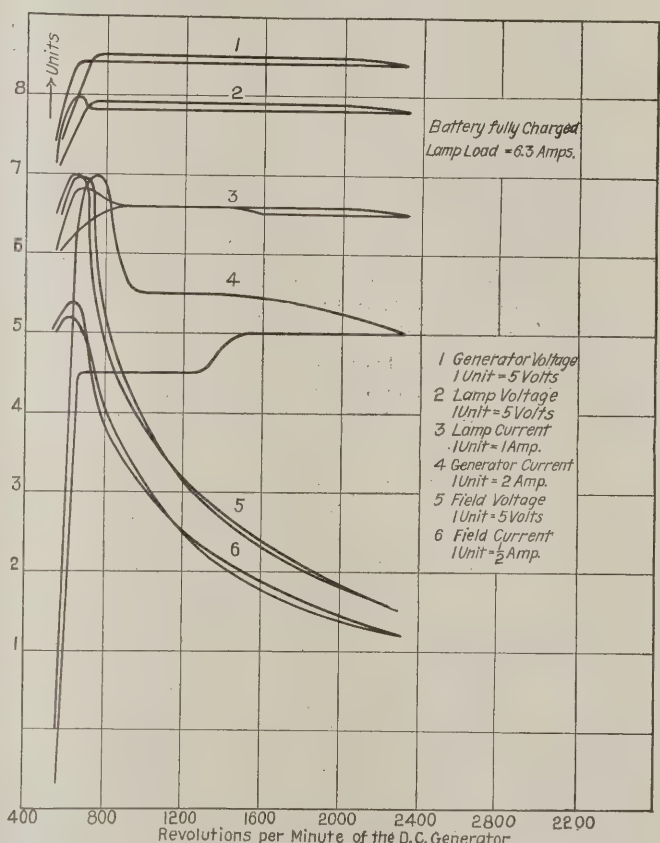


Fig. 6. Results of a Series of Tests Made in This Country With a Type of Automatic Regulator Similar to That Shown in Fig. 4.

in lamp voltage is about 3 per cent and occurs between the two following extreme service conditions:

1. Running with the lamps inserted and completely discharged battery.

2. Running with the lamps inserted and completely charged battery.

In practice these variations in lamp voltage are of little consequence, as they take place gradually. When running with dimmed lights, for example, when only 20 per cent of the full lighting current is required, the apparatus increases the generator and lighting voltage by about 3 per cent so that the dynamo, relieved of the lighting current,

will be called upon to supply an increased amount of current to the battery, that is, it will then be fully utilized.

Even in the most unfavorable case, i. e., when a dynamo is charging a fully discharged battery with the full lighting current switched on, the machine will not be subject to any dangerous overloads. This is ensured by the solenoid coil *M2*, which is not fully short-circuited after the lights are switched on. Although the switch *A* is closed, a reduced amount of current flows through coil *M2* inserted in the shunt of the main circuit, and the magnetic effect of this coil increases that of the voltage coil *M1*. As soon as a surge occurs in the armature current, the magnetic field of the solenoid *M* will be strengthened, whereupon the metal band will be lifted slightly higher, thus reducing the dynamo voltage.

Operation of the Regulator in Connection With Batteries

As mentiond above, the Brown-Boveri regulator requires the use of only one battery. Usually lead cells are used. Recently, however, some railroads have adopted the use of alkaline cells and it is interesting to note that this regulator can be adapted easily to this type of battery. As is generally known, the voltage curve of the alkaline battery is almost vertical in the initial stage of charging and rises very slowly thereafter so that it is very difficult to determine accurately at what time this type of battery is fully charged. In the case of lead batteries, the curve rises very regularly from the beginning and turns up suddenly towards the end. This sudden bend in the curve makes it possible to determine exactly when the lead battery is fully charged. During discharge the voltage curve of the alkaline battery falls much more rapidly than that of a lead battery under the same conditions. These factors were taken into consideration when designing the Brown-Boveri regulator so that it may be adapted to either type of battery. The adjustment of the regulating device for either proposition is very simple and can be taken care of easily by the inspecting railroad personnel.

In case of coaches being out of service for considerable time during which the lead batteries discharge themselves, it is known that the lead plates become hard through sulphation. These plates offer a high resistance to the current when the battery has to be recharged. In this case it is necessary to begin the charging process with a low current and an abnormally high voltage and complete it thereafter with a heavier current. This operation can be taken care of in special charging stations and for this process the batteries have to be removed from the cars. The Brown-Boveri regulator is designed to correct this condition automatically. The apparatus is provided with a so-called desulphating relay for the purpose of avoiding costly and troublesome charging of sulphated batteries. This device consists of relay *S* and contact *T*. In standard service the contact *T* is opened each time the train is set into motion. In case of sulphated batteries, the small charging current flowing through the solenoid *S* is no longer sufficient to operate the switch *T*. The contact, therefore, remains closed, causing part of the winding *U1* to be short-circuited. The resistance conditions are so calculated that the charging voltage relay cannot respond as long as the switch *T* is closed. With this arrangement the dynamo voltage can rise beyond its normal value, allowing the battery to take up a small amount of charging current which increases very slowly. As soon as this current reaches its normal value, the relay *S* operates, the switch *T* opens the contacts and normal working conditions are resumed.

Articulated Cars for Metropolitan Subway

The first two Type "D" Articulated Cars to be placed in subway service by the Brooklyn Manhattan Transit Company are each equipped with 4-GE-282-600 volt motors and a type PC-15 controller for each pair of motors. The control equipment has several novel features, some of which are used to adapt the apparatus to this specially designed car. Certain features have been embodied in this control at the request of the customer and others to include the latest improvements in this type of equipment.

Two driving motors are mounted on the truck of the outside end of each unit and the controller is supported underneath the end unit of the articulated car adjacent to the motor truck. The two main controllers are actuated from a C-176 master controller, one of which is located in each end cab. These controllers are coupled permanently in parallel through a jumper cable which carries the control circuits. The master controller is equipped with the usual deadman's release and is also provided with a plug receptacle above the master controller, which controls the operation of the electric-pneumatic brakes. The plug for this apparatus is attached by a chain to the motorman's reverse handle.

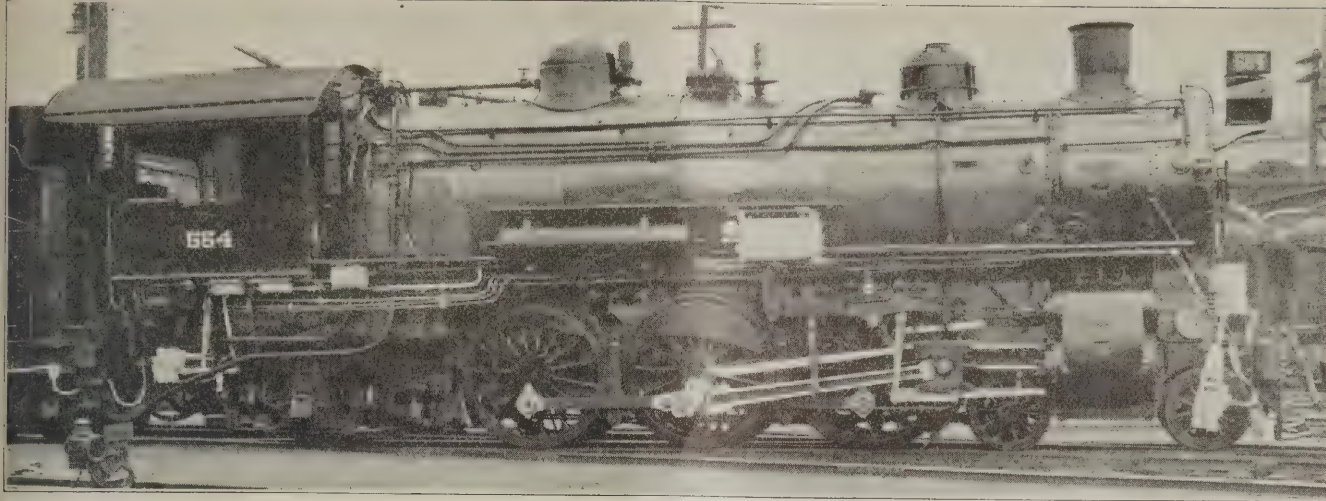
A feature of the electric-pneumatic controller is the addition of coil springs on all control and reverser fingers to insure a perfect contact with the rotating cylinder at all times. Another feature is the use of flexible cables passing through slotted wood cleats at the end of the controller instead of having the conduit permanently coupled to the controller itself. This facilitates maintenance, effectively insulates the controller from the car body and allows the controller to be removed without disturbing the conduit.

A relay is also provided to give dynamic braking to stop the train in case of loss of power.

Another feature is the accelerating relay which is so designed that it gives a constant rate of acceleration with varying passenger loads. The line breakers for this equipment are mounted in a separate box from the main controller. This box also contains overload relays which are provided with coils in circuit with each motor.

The control circuit is taken from a 32 volt battery, which is charged through resistance directly from the third rail. A set of relays which is also mounted in a separate box regulates the charging of the battery. Further protection to the equipment is provided by a quick acting protective relay which shuts down the controller in case of loss of voltage. All contacts on this device are of Graphalloy to minimize burning of the tips.

The GE-282 motor is similar in design to the GE-248 of which there are 1,800 in operation on the B. M. T. lines. A number of improvements have been added including a new design of fan and a redesign of the commutating poles. It has an hourly rating of 200 horsepower of 600 volts and is arranged for multiple ventilation. Compressed air for the brakes and control equipment is supplied by two CP-30 compressors mounted under the center section of the unit.



Typical Locomotive with Train Control Equipment Painted White for Illustration

Train Control on the Norfolk & Western

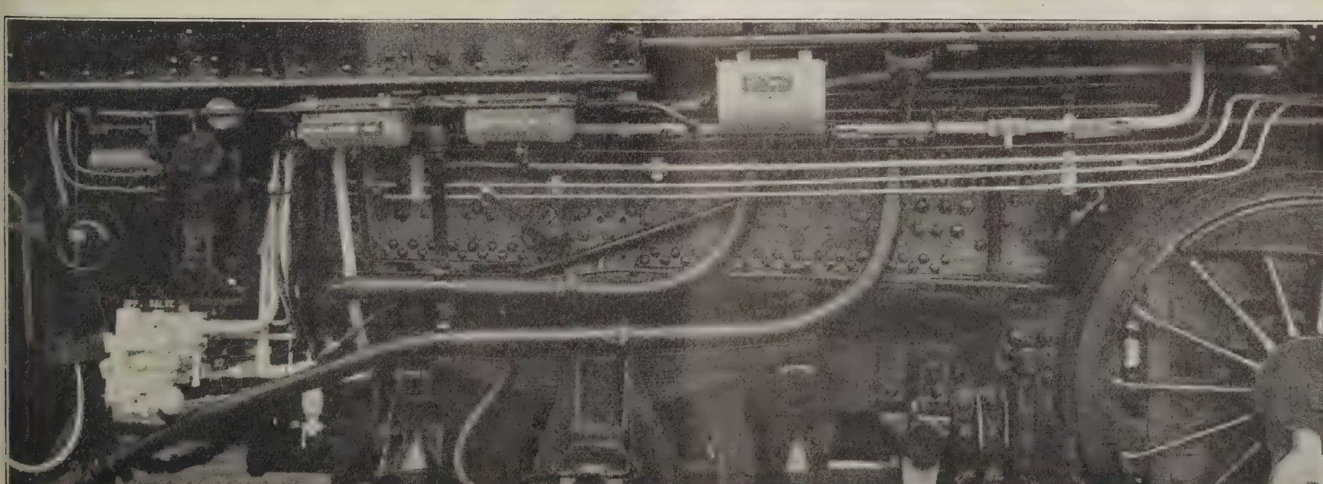
Three-Speed Continuous Inductive System Makes Good Record on Single Track Division

THE Norfolk & Western Railway has installed the three-speed continuous inductive train control system as manufactured by the Union Switch & Signal Company on its single track division of 108 miles, Hagerstown, Md., to Shenandoah, Va., the installation including a complete new system of automatic block signaling of the a. c. position-light type. This installation was made in compliance with the order No. 13413 of the Interstate Commerce Commission dated June 13, 1922, and construction is now under way to extend the installation from Shenandoah to Roanoke, 132 miles farther, in compliance with the order of January 14, 1924. The installation was commenced in December, 1923, and placed in service on November 10, 1924, with six equipped engines. Two additional passenger and 33 freight engines, making a total of 41, were put into service February 15, 1925.

Detailed Operation of Continuous System

The wayside portion of the system consists of alternating currents in the rails, one, the usual track current, flows down one rail, through the track relay or the axles of an occupying train and back in the other rail as shown in Diagram 1. Another train control circuit called the "loop circuit" flows through all or a part of a track circuit through both rails in multiple and returns on a line wire. This latter circuit is polarized, that is, when the next block ahead is clear the current at a given instant will flow through the rails in one direction, but if the next block is occupied, the current at that instant will flow in the opposite direction. The track current flow, Diagram 1, is shown by the solid arrows and the loop current by the dotted arrows. It will be noticed that when the next block is occupied the loop current is not only reversed in direction but part of the track circuit, between the *B* point and the stop signal, is deprived entirely of loop current. There are, therefore, three different conditions of loop current relative to the track current, that is, loop current of one relative polarity, loop current of the other relative polarity and no loop current.

The appearance of the train control devices on the



Application Valve, Quick Release and Acknowledging Reservoirs Under Cab

engine is shown in an illustration. The locomotive equipment consists of the track receiver coils between the pilot and the front wheel; the speed control valves and centrifuge, above the pilot, driven from the outer end of the front axle; the instrument case just ahead of the main reservoir; the brake application valve group below the cab; and the loop receiving coils at the rear of the tender. Diagram 1 includes briefly the electric control elements of the system, while Diagram 2 shows this in complete detail.

The alternating currents in the rails generate voltages in the receiver coils by induction, which are so connected that the track receiver coils are affected only by the track current flowing in opposite directions in the two rails while the loop receiver coils are only affected by the loop current which flows through both rails in the same direction. These voltages are amplified through audion amplifiers and conducted to the train control relay which they operate.

Form S. E. 30

NORFOLK AND WESTERN RAILWAY COMPANY

OFFICE OF SIGNAL ENGINEER

Roanoke, Va., May 2nd, 1925

Report of Automatic Train Control Performance

From Hagerstown, Md. To Shenandoah, Va.
April 1st, 1925 To April 30, 1925, inclusive

NUMBER OF ENGINES IN SERVICE MONTH OF April, 1925 .... Passenger 7, Freight 26, Total 33

NUMBER OF ENGINES IN STORAGE MONTH OF April, 1925. .... Passenger 1, Freight 8, Total 9

Percentage of perfect trips to total trips - April - 97.7%
" " " " " " " - March - 96.00%

ENGINE	Total Number of Trips	No. of Trips with A. T. C. Cut Out	No. of Perfect Trips	FAILURES: ENGINE Elec.	FAILURES: ENGINE Pneu.	FAILURES: Wayside	FAILURES: Other Causes	FAILURES: Undetermined	FAILURES: Total ~~Failures~~ per Engine
Passenger									
544	40	0	40	0	0	0	0	0	0
547	37	0	37	0	0	0	0	0	0
551	[illegible]	0	[illegible]	0	0	0	0	0	0
554	30	1	29	1	0	0	0	0	1
557	37	0	37	0	0	0	0	0	0
576	41	0	41	0	0	0	0	0	0
579	[illegible]	0	[illegible]	0	0	0	0	0	0
Freight									
431	53	0	52	0	0	0	1	0	0
433	10	0	10	0	0	0	0	0	0
434	21	0	20	1	0	0	0	0	1
448	41	0	41	0	0	0	0	0	0
449	34	0	34	0	0	0	0	0	0
468	30	0	30	0	0	0	0	0	0
1100	[illegible]	0	[illegible]	0	1	0	0	0	1
1103	6	0	4	0	2	0	0	0	2
1114	10	0	9	1	0	0	0	0	1
1116	21	0	20	0	1	0	0	0	1
1119	21	0	21	0	0	0	0	0	0
1123	3	0	3	0	0	0	0	0	0
1125	3	0	3	0	0	0	0	0	0
1127	2	0	2	0	0	0	0	0	0
1131	[illegible]	0	[illegible]	0	0	0	0	0	0
1135	4	0	4	0	0	0	0	0	0
1139	19	0	19	0	0	0	0	0	0
1143	17	0	17	0	0	0	0	0	0
1146	19	0	19	0	0	0	0	0	0
1148	1	0	1	0	0	0	0	0	0
1149	2	0	1	0	1	0	0	0	1
1151	12	0	11	0	1	0	0	0	1
1152	20	0	20	0	0	0	0	0	0
1153	11	0	10	0	1	0	0	0	1
1158	4	0	4	0	0	0	0	0	0
1159	14	0	12	0	2	0	0	0	2
	606	1	592	3	9	0	1	0	12

Engine Failures - - - - 12
Other Causes - - - - 1
Total - 13

The Record of Operation For April Shows Only 13 Failures, 12 of Which Were Engine Failures, 3 Being Electrical and 9 Pneumatic

The train control relay is so designed that when the polarity relation exists, as in approaching a clear block, its contacts are swung to the right, or normal position, as shown in the diagrams. With the polarity relation which exists between *A* and *B* in the rear of an occupied block, the contacts are swung to the left or reverse position. When the loop circuit is absent, as between *B* and *C*, in the rear of an unoccupied block or when the track current is absent, as in an occupied block, the relay is de-energized and the contacts are moved by gravity to the middle position. These three relay positions respectively set up the high, medium and low speed limits and illuminate corresponding indications in the cab.

How Train Control Affects the Air Brakes

The centrifuge, which is driven by the front axle, has several small poppet valves, one opened at each of the speed limits and, when open, act to initiate a brake application if the speed of the train exceeds the speed limit set up by the train control relay as determined by traffic conditions in advance. This automatic brake application may, however, be suppressed if the engineman previously makes a proper and sufficient manual application. He may then release the brakes when the train is retarded to the proper speed.

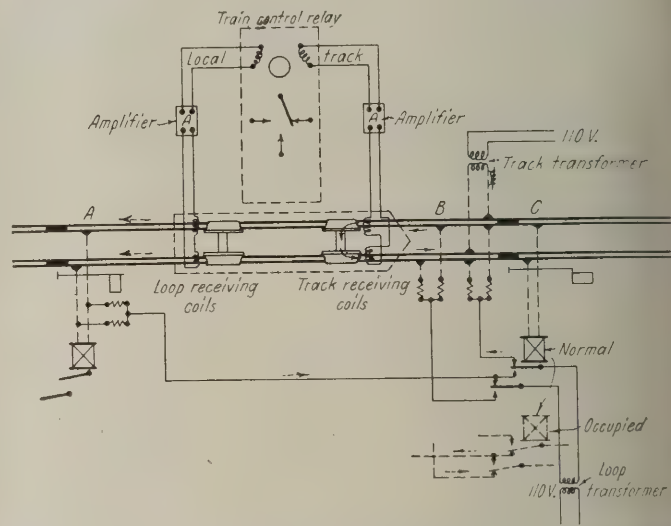


Diagram 1—Typical Train Control Circuits as Tied in With Signaling

The automatic brake applications are always split, the first reduction being from 7 to 8 lb., followed automatically, when this reduction is completed, by a further reduction of about 13 lb. This is an important feature of this system because of the well known smoothness of stops and the absence of destructive shocks throughout the train when the slack is run in too violently as occurs in a continuous service reduction.

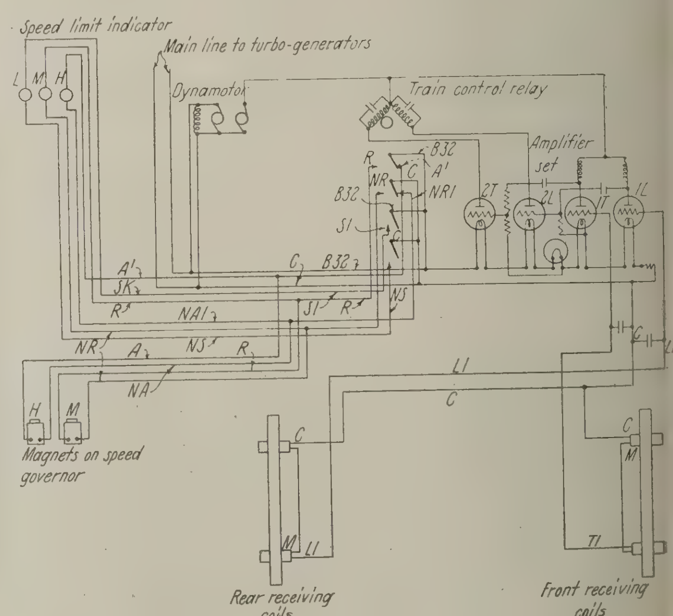
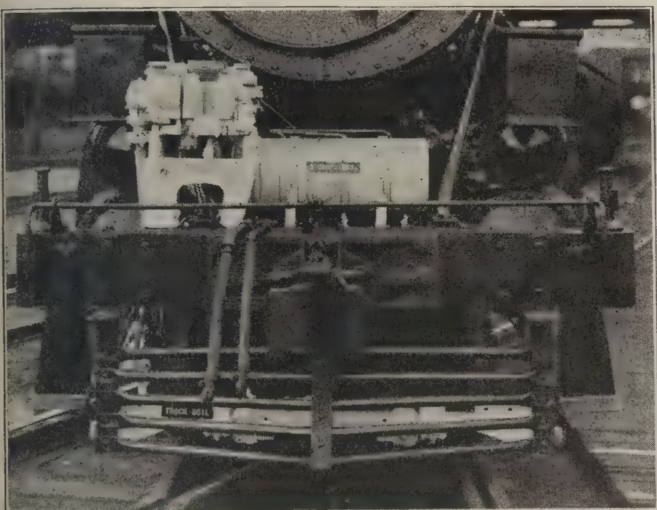


Diagram 2—Locomotive Train Control Circuits

When the brakes are automatically applied they cannot release themselves. It is always necessary for the engineman to lap the brake valve until the proper speed limit is reached. The automatic brake application valve then restores and then, but not until then, can the handle be returned to the running or release position.

Failure of any wire or part of the apparatus will restrict the train to either medium or low speed. In such an event a sealed cutout cock may be operated, permitting the train to run without train control, but the breaking of the seal will have to be accounted for. The speed



Front View Showing Governor and Track Coil Suports

limit indicator may still be operative so that the engineman may control the train manually.

The work of installing both the automatic signals and the wayside train control apparatus was handled by the signal department forces with the co-operation of the telegraph department and the Shenandoah division officials and organization. The plans were prepared by the signal department in co-operation with the Union Switch & Signal Company's engineers.

An excellent record has been made since the system was placed in service and tuned up. It took some little time to clear up adjustments and minor faults which are always necessary after a large construction job, but since then the performance has been very satisfactory, and as the maintenance men become familiar with the system, further improvement in operating results will be realized.

Brush Setting*

Sparking at the brushes on motors and generators may be due to a variety of causes. It seems that almost any defect in either design, manufacture or operation is manifested by sparking. Improper brush setting is one of the contributing elements to poor commutation, and, at the same time, one of the most frequently neglected. This article will deal with brush spacing and the setting of brushes upon the proper electrical neutral.

One of the important points in the satisfactory operation of multipolar motors and generators is the correct spacing of the brushes around the commutator. Incorrect spacing may be due to one of the following causes:

1. Unequal spacing of brush studs.
2. Dissimilar assembly of holders.
3. Dissimilar assembly of studs to which the holders are bolted.
4. Unequal spacing of the field poles.
5. Unequal air gap under the field poles.

The setting of brushes upon the electrical neutral is usually accomplished by a trial. The brushes are moved back and forth until the position is found at which there is no sparking, or, at least, the minimum of sparking at the average load. The electrical neutral may also be located by means of a voltmeter. This method will be described later.

Brush Spacing

The correct spacing of brushes varies for motors and generators and for interpole and non-interpole machines. Before any adjustments are made, the first step is to see that the brush studs are equally spaced around the commutator. This is done by setting the studs an equal distance apart, and also at the same distance from the commutator. Perhaps of more importance than the spacing of the studs is the necessity of having the studs parallel to the axis of the commutator and all brush holders on each stud in perfect alignment. This can be checked by observing whether or not each brush on each stud is the

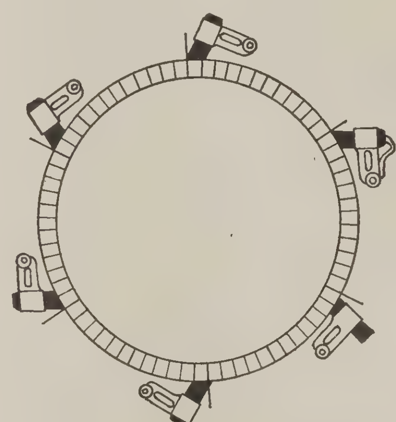


Fig. 1

same distance from the edge of the nearest commutator segment as is the brush which is used in checking the brush spacing.

The best means for determining the correct spacing of the brushes is to cut a strip of paper of a length just equal to the circumference of the commutator and mark off on this paper as many equal divisions as there are brush studs, then placing the paper around the commutator and setting the brushes accurately to the mark. It is possible to have the brushes slightly off the neutral points even if the studs are equally spaced. This is illustrated in Fig. 1.

Here the spacing of the studs is uniform, but the brush holder on stud A has been rotated too far from the commutator, and the holder on stud C has been rotated too near the commutator. This throws one brush one-half bar ahead of the neutral and the other one-half bar back of the neutral. This difference of one bar is enough to cause a very heavy short circuit current to flow unless the neutral field is unusually wide. Incorrect spacing causes very heavy short circuit currents between brush studs of the same polarity through the connecting bus

*Abstract from Bulletin published by the National Carbon Co.

bar leads. The voltage behind this short circuit current is low, being only the difference between the maximum and minimum commutator volts under the incorrectly spaced brushes, but the current is higher, because the resistance of the short circuit path is low.

After the brushes have been properly spaced by the above method, and if there is still some evidence of short circuit currents between studs, the trouble is probably due to unqually spaced fields or unequal air gaps. Due to faulty manufacture, it sometimes happens that the field poles are not equally spaced on the motor or generator frame. This causes a distorted magnetic field and an unequal shifting of the neutral point.

If the field pole spacing and the brush spacing are correct, unequal sparking at different brush studs may be due to unequal air gaps. This may be occasioned by worn bearings, which allow the armature to run nearer the lower field poles. As the magnetic flux depends largely upon the length of the air gap, the lower coils, as shown in Fig. 2, will move through a stronger magnetic field, and will generate a higher voltage. Therefore, they will carry the greater part of the load, and, in cases of excessive wear, may carry the entire load. This difference of load at the different brush studs will cause an unequal shifting of the neutral point. The lower studs will not only be carrying more than half the load, and will also be out of the neutral field, and will have the heavier short circuit currents, with the usual results of sparking, pitting of the brushes and blackening of the commutator. This same effect may occur at one side of the machine, due to the wear caused by belt pull, or it may occur in a cheaply built machine

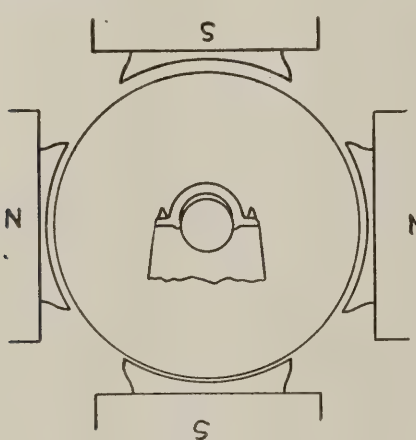


Fig. 2

when the field poles are of unequal length. This last condition may be remedied by loosening the shorter field poles from the frame and slipping thin sheet iron liners back of them.

Non-Commutating Pole Machines

Generators and Motors—Although, with these machines, it is impossible to hold the position of the electrical neutral constant with a change of load, its displacement will be small in a well designed machine. On a machine where sparking is experienced, a compromise position can usually be found which will satisfy all requirements. On this type of machine, the brushes are usually set by trial in the following manner: The machine is run at no load in its normal direction at normal speed, using a normal field current. Then shifting the brushes forward (i.e., in the direction of rotation) from the mechanical neutral point if the machine is a generator, backward if it is a motor until they begin to spark. Apply full load and locate the brushes for the best commutator position under this condition. This full load neutral will be farther away from the mechanical neutral than was the no load neutral. In making a selection for a permanent brush position which will be between these two neutrals it is well to

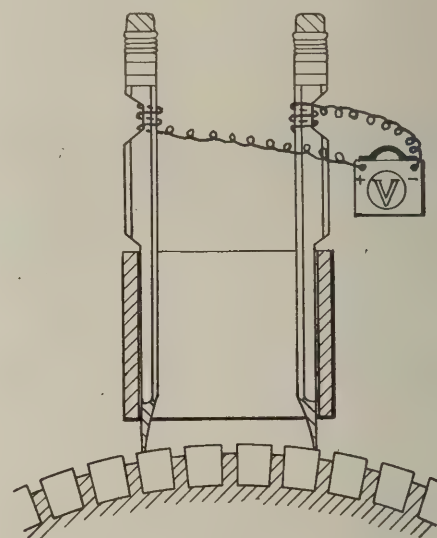


Fig. 3

choose a point closer to that one which comes nearer to the average load under which the machine will operate.

Commutating Pole Machines

Generators—There are several methods whereby the location of the operating neutral on a generator of this type may be found. It is especially important on commutating pole machines that the brush studs be placed accurately, as previously described, and that a good fit of the brushes to the commutator be obtained. The brushes may be accurately set on this type of machine by means of a voltmeter in the following manner: Cut two lead pencils down on one side until only a thin layer of wood protects the lead. Near the tip of each pencil expose the lead, to which attach the voltmeter leads or flexible lamp cord. Remove one brush, hold the pencil in the brush holder with the points on the commutator and the flat side of one pencil against the back edge of the holder, and the flat side of the other pencil against the front edge of the holder, as shown in Fig. 3. This will show the voltage generated across the brush which is generally called "commutation voltage." This operation should be repeated for one holder on each brush stud and the holders adjusted so that the voltage measured by the above method is the same except that on the positive studs the direction of the commutation voltage should be in the opposite direction from that on the negative studs.

Motors—A commutating pole motor has its brushes set on the operating neutral if it will run at the same speed in either direction when under the same conditions of applied voltage, field current and load or at no load. The brushes having been placed approximately at the no load neutral, the machine may be loaded and the permanent brush position accurately located by careful speed readings at any load, shifting the brushes slightly until the same speed is obtained in each direction.

The D. T. & I. Electric Locomotive on the Test Track at the Rouge Yards

D. T. & I. Electric Locomotive Completed

Unique Type of Twin Motive Power Unit Has Many Unusual Features of Design

THE electric locomotive for the Detroit & Ironton which was described in the *Railway Electrical Engineer* of December 1924 has been completed and placed, ready for test, on the four-mile section of the D. & I. now equipped with overhead trolley. The previous article describing this locomotive dealt principally with its electrical features, while this one, through the courtesy of the D. T. & I. Railroad News concerns particularly the many unusual features of mechanical construction.

The locomotive is of the motor-generator type. Alternating current of 25 cycles, single phase, 22,000 or 11,000 volts is supplied by the trolley and stepped down to 1,250 volts in a transformer carried in a cab of each of the two sections. It is then converted into direct current of variable voltage by means of a motor-generator which feeds eight traction motors of the direct current series type connected in parallel.

This type of locomotive also will be able to operate in the same train with any other type of alternating current locomotive and can easily be adapted for running on any 25-cycle trolley voltage, although it is especially designed for either 11,000 or 22,000-volt supply.

It is designed to develop a maximum of 5,000 hp. and a maximum starting effort of about 250,000 lb. based on a total weight of 372 tons distributed over 32 driving wheels. Normal rating is 4,200 hp. at 17 miles an hour and 3,600 hp. at 25 miles. Overall length is 117 feet, but the longest rigid wheelbase is 11 feet.

Speed control for both motoring and regeneration is very flexible. It comprises 45 steps and is effected from standstill to 17 miles an hour by regulating the main generator voltage and from 17 to 25 miles by running the motors with separate and variable excitation. The converter set is started by means of an auxiliary 60 cell storage battery from the d. c. main generator side, and brought up to half speed. The synchronous motor then accelerates it to full speed and synchronizes the set entirely automatically.

Mechanical Design

There is a radical difference between the new D., T. & I. electric motive power unit and standard steam or electric locomotive practice in its mechanical design.

The locomotive is primarily a freight engine, of 0-8-8+8-8-0 wheel arrangement. It consists of two motive power units semi-permanently coupled together, each one carrying its own full equipment. Each motive power unit consists of two articulated eight-wheel trucks connected by a universal hinge of the ball type.

The leading truck carries an automatic oil circuit breaker, a 2,000 k.v.a. stepdown transformer, a compact group of equipment, an air compressor for the traction brakes, a blower for ventilating the traction motors and a transformer oil cooler. A centrifugal oil circulating pump for the transformer oil is also driven off the blower shaft.

The trailing truck carries a 750 r.p.m. motor generator set consisting of a 60-cycle, 1,240-volt synchronous motor, a 600 volt d. c. geerator, a 75-kw., 125-volt main exciter and a 25-kw., 10-volt regenerative exciter. A compact group of equipment is placed ahead of this set while smaller groups of switches and various other equipment are located on the bulkhead between the engineman's and machinery compartment. Each power unit has 8 traction motors of the direct-current, 600-volt series, axle hung type of 225 hp. each. These motors with their gear, drive axles, and wheels form a unit and are interchangeable as an assembly as well as in parts. Each motor is geared to the driving axle by two 22 tooth 3½ d. p. spur pinions left, and right, each meshing with a 98 tooth gear rim which is shrunk onto the cast steel wheel center. Both wheels are pressed to a 9-in. axle which rests in two fixed bronze bushings each 14-in. long fitted into the motor

housing. Collars are provided on the bushings to take any axial thrust of the wheels.

The journals were given generous proportions to minimize deflection of the axle and make a quiet running gear. Both pinions are flexibly connected to the motor by a quill drive of simple and efficient design. The hollow motor shaft carries the armature and rests in two bearings of standard design. Inserted, and keyed to it internally at half length is a flexible propeller shaft which has fastened to each end a driving pinion. These pinions again have shanks fitted loosely in the hollow armature shaft. Such arrangement permits the pinions to rotate relatively to the hollow shaft as well as to each other just enough to insure a good mesh with both gears, and absorb any vibrations in the drive. This mechanism was submitted to quite a severe run on the test floor equivalent to about two years' road service and has proved very satisfactory.

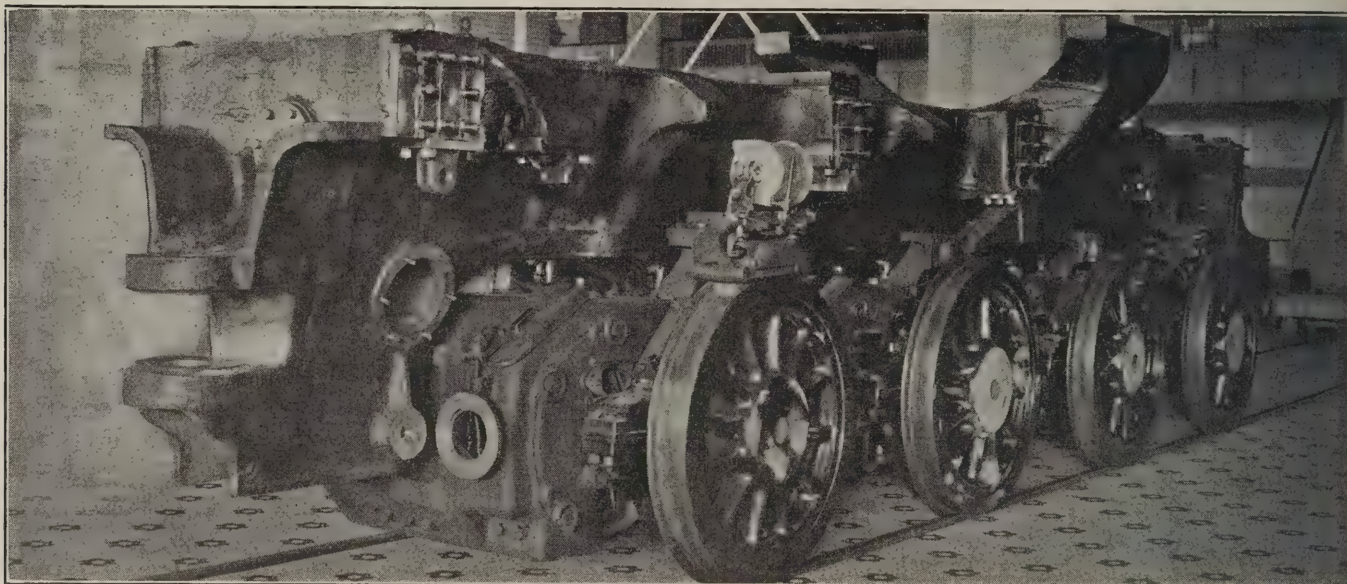
Equalization

Each motor unit is suspended in three points and guided in an additional fourth one in the following way: The tractive force of each motor is transferred to the locomotive frame by a universal ball and socket joint while the weight of the upper locomotive structure rests on two equal beams located directly above the axle. Two brackets reaching out from the motor housing serve as supports for the equal beams. In order to keep the motor units lined up on the track and prevent any lateral motion, a point opposite the universal suspension joint with respect to the axle is guided vertically in a frame extension. Only six motors for each power unit, however, are assembled this way while the leading and trailing axles have spring buffered guides to allow a maximum of 2-in. lateral motion each way in curves. The equal beams mentioned above rest on rocker pins and are flexibly suspended on a series of leaf springs, the whole system forming a spring rigging with 5 fixed points for each truck.

Frame

The main framework for each truck is built up of three main members, a center frame and two side frames. The center frame is a heavy box-shaped hollow steel casting which may be considered as the backbone of the locomotive. It is provided with suitable extensions to take care of the heavier equipment mounted directly on it, while the inside is partitioned off to form a main air reservoir and a supply air duct for the traction motor ventilation. The cooling air is forced into this casting by the blower mounted directly above and from there is distributed to the individual motors through flexible metal bellows. Another large flexible canvas air duct connects the two adjoining frames across the mallet hinge.

To the left and right of this center frame casting and parallel to it are bolted two channel-shaped castings which form the outer side frame, and serve as a support for a structural steel cab platform. These channel side frames with their openings facing to the outside are used for starting battery compartments and hold also some smaller electrical and mechanical equipment. The outside of these compartments is covered by curved sheet steel hoods on hinges, which can be unlocked for access to the battery.



One of the Two Running Gear Sections Which Carry the Motor-Generator Units, Showing Cradle for Supporting the Unit. Air Brakes Such as the One Shown on the Wheel in the Foreground Are Provided for Six Wheels on Each of the Four Sections

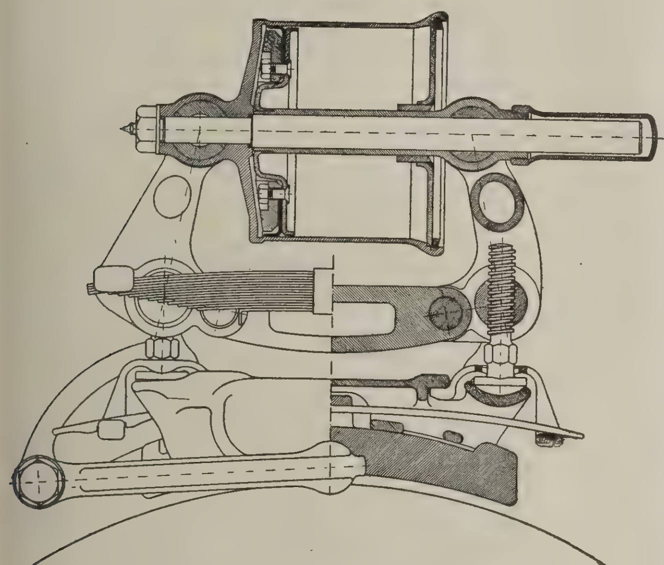
Transformer and Motor-Generator Mounting

The motor generator, the heaviest part of the equipment, is designed as a unit, with generator and ventilating fan in one housing and resting on three points on the center frame casting. Both exciters are carried on shaft extensions, ventilation air is drawn through the end shields and exhausted into a funnel attached around the fan near the center of the set. The sides of the uptake as well as downtake are provided with shutters which may be manually or automatically operated either to circulate the hot air into the cab in cold weather or exhaust it completely into the open.

The transformer, the second heaviest part of the equipment, has an oil-cooled core housed in a welded oil tank made up of ¾-in. boiler plate. It was designed to carry the automatic oil circuit breaker in such a way that the transformer cover is actually a unit with the circuit breaker body. Series parallel connectors, to change the transformer primary from 22,000 to 11,000 volt trolley voltage, are placed inside the tank and can be easily reached

through a manhole in the tank cover. Voltage and current transformers for meter and relay supply are placed inside the tank. The cable connector between breaker and transformer primary is also under cover while the cable leading from the pantograph to breaker enters the breaker casting through the roof. The protective resistance for the breaker is built into the breaker oil tank which again can be lowered for breaker point inspection by means of lift screws, gears, and a crank located on the cab roof.

The object of this unit arrangement is to eliminate from the inside of the cab all exposed leads which carry trolley voltage. Transformer and oil circuit breaker are designed for a maximum degree of safety against any oil explosions which may occur in them; both are also provided with emergency vents through the cab roof.



Vertical Section Through Individual Air Brake

As mentioned above, cooling oil for the transformer is circulated by means of a small centrifugal pump driven off the motor blower. An oil-cooling radiator is placed on top of the traction motor blower, from which the cooling air is drawn, and exhausted through the cab roof. This blower is of the double suction type with aluminum rotor running normally at 1,650 r.p.m., driven by a d. c. motor. A control interlock will allow the blower to slow down to half speed when the speed control lever is in "Off" position.

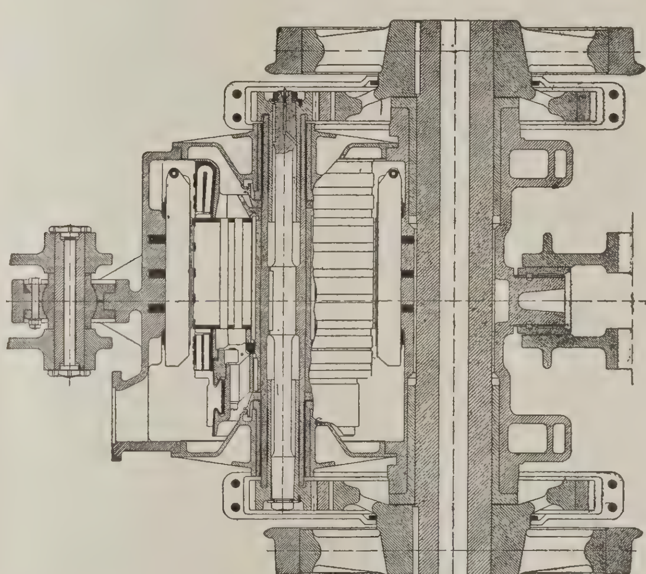
Control Apparatus

A master controller of new and very compact design is installed on each end of each motive power unit. Due to the multiple control feature any number of motive power units may be operated from any control stand. It contains the necessary contact drums, three operating levers mounted on telescoped horizontal shafts, the air brake valve in horizontal position on a bracket extension to the right, and the sander foot control. A number of minor controls, as whistle, bell, light and reset switches, double cutout cock are also provided. A gage board with illumination and train control lights is mounted on top of the skeleton frame and a smooth aluminum cover incloses all piping and contact mechanism.

Cab

The cab is constructed in the usual way but made of heavier stock than customary. The outside walls are ¼-in. plates. Partitions and inside walls for the double-walled engineman's compartment are 3/16-in. thick. The two cab halves are joined by a flexible canvas diaphragm consisting of six metal reinforced folds suspended by two universal ball joints from the cab roof. The center portion of each half cab can be lifted away, while the engineman's compartment and the section nearest to the articulation remain in place.

This feature facilitates work in case of heavy overhauling. There are 8 sandboxes in each motive power unit which form part of the cab walls with filler caps on the roof and sand traps at the bottom. All windows slide vertically in cast bronze frames. There are two large equipment assemblies, one located on supports in each half cab. Switches and relays were grouped and assembled so that nothing extends above 50-in. elevation from the floor with ample space for passages on the sides. This arrangement allows a free view over most of the apparatus and give an appearance of roominess and neatness. All live high tension conductors and projecting parts are carefully covered with grounded, perforated metal guards in such a way that the inside of the cab may be considered as absolutely safe electrically to the personnel. All cables and most of the piping are laid within the structural cab subframe between two decks of flooring so that very few pipes or conduits may be seen. All cable crossings over the articulation are made flexible with plenty of allowance for extreme movements.



Horizontal Section Through Traction Motor. The Ball Joint Between the Traction Unit and Locomotive Frame Is Shown at the Left. At the Right Is the Square Block Which Slides Vertically in the Frame for the Purpose of Keeping the Motor Line Up with the Frame

The standard pantographs are fitted with aluminum tubing protectors extending to left and right in bow fashion to prevent the contact horns from getting caught in the catenary.

Brakes

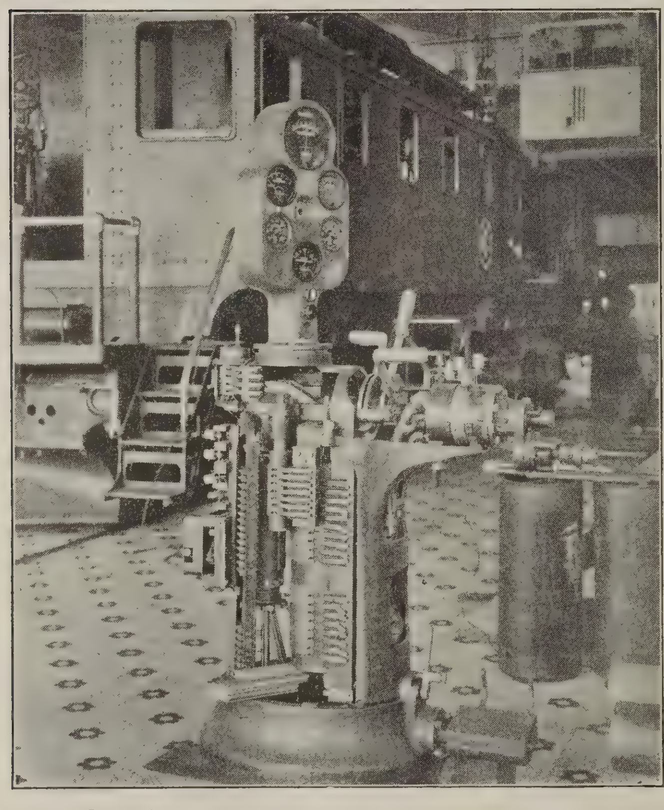
A radical departure from common practice was made in the air brake. Large air cylinders, complicated linkages and side brake shoes were replaced by individual brakes for each wheel except for those of the leading and trailing axles. The object of this change was to do away

with all cumbersome obstructions which are involved with the use of many links, levers, and so on.

The new design provides for a small air cylinder on top of the wheel supported on a traction motor housing extension. With compressed air admitted, cylinder and piston travel in opposite directions forcing a single brake shoe down upon the wheel tire through multiplying levers. A flat leaf spring releases the brakes when air is exhausted. The forces exerted by this mechanism will not affect the cab springs but will merely relieve the axle journals of a certain amount of weight or, in other words, a weight transfer will take place from the journal to the top of the tire.

The whole mechanism is very simple. Most of the parts are interlocking and may be taken apart with but few tools and in a few operations. All other parts of the air brake equipment are of standard design.

Entire locomotive equipment, mechanical as well as electrical, has been excellently finished. All visible bolts, railings and minor finished details are nickel-plated. The frame work, wheels and running gear up to the cab line



Master Controller with Covers Removed, Showing Brake Valve in Horizontal Position, Operating Levers Upright, Control Drums, Sander Pedals, Gage Board and Miscellaneous Switches

are painted mahogany red with black trimmings while the cabs are lacquered in deep satin green. The windows are plate glass, affording clear vision in all directions.

The mechanical parts of the locomotive were designed and built by the Ford Motor Company, while the electrical equipment was designed and built to Ford Motor Company's specifications by the Westinghouse Electric & Manufacturing Company. Electrification of the first 16-mile section of the Detroit, Toledo and Ironton from the Rouge Yards to Flat Rock, which is well under way, is the initial step in electrifying the system from Detroit to Ironton, Ohio.

Shop Made Apparatus

By Alfred C. Turtle
Shop Electrical Engineer, Canadian National Railways

In large industrial plants demands are often made of the electrical departments for appliances to meet peculiar heating problems, electro-magnetic propositions, and peculiar adaptations of motor drives. We have numerous instances of this kind, some of which are very interesting in their applications, and which in view of the success obtained, are worth mentioning.

Spot Welder

Some time ago before such a thing as a saw brazing device of the electric type was on the market, I was approached on the particular problem of the brazing of band saws electrically. The request was for a machine capable of handling any size band saw up to five inches, and the demand was very urgent on account of the Fire Commissioner's requiring the removal of the existing furnaces, used for heating the brazing irons, from a dangerous location. On carefully going into this proposition it was found that something in the nature of a spot welder would be suitable, except that a somewhat finer control of heat application and mechanical arrangement would be necessary. It was also found that metal to metal contact, and the subsequent severe localization of heat on the band saw joint when between the jaws of this apparatus, was a detriment to the saw metal itself, and therefore, we had to seek some means of producing a steadier and more controllable heat. This was done by using carbon plates, one on top and one underneath the saw joint, and also by applying a magnetic primary switch, operated by means of a push button station. By this means, together with the use of a shop made transformer tap switch, we were able

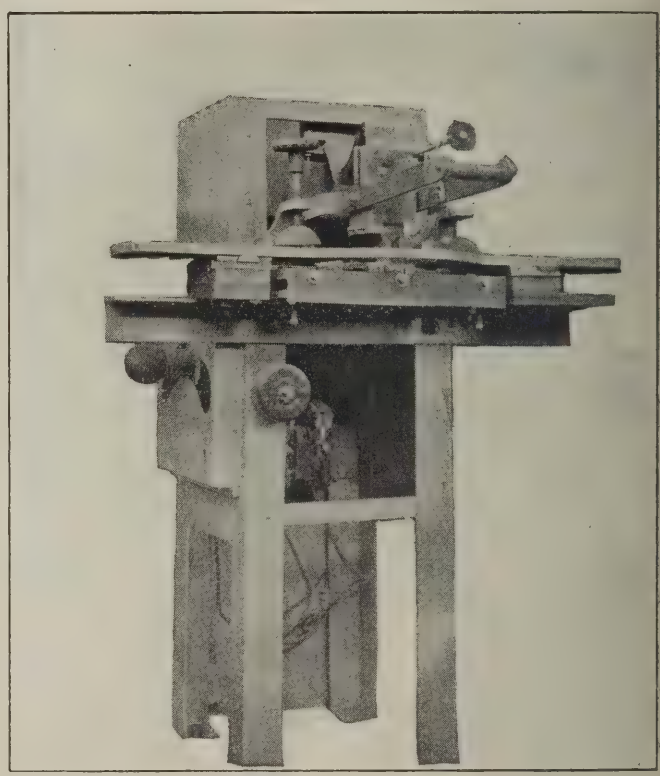


Fig. 1—Shop Made Saw Brazer

to produce a machine practically perfect in operation for this work.

It is interesting to note that the application of magnetic switches for the primary current with push button control has been extended to all our rivet heaters, and has been found of great value. The old type, with a plate contact and a long wooden handle, seemed to have a peculiar effect on our rivet heater boys, who could not be persuaded that harder pushing on this handle did not get more heat on

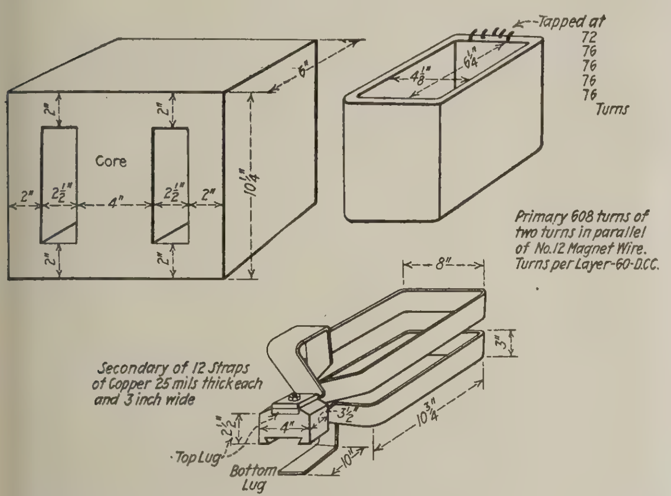


Fig. 2—Primary and Secondary Winding Details of Electric Saw Brazer

the rivet. We consequently had an era of broken handles and therefore abolished the device, and incidentally made the apparatus safer to handle.

Fig. 1 shows general appearance of the saw brazer. The top lug or head is pressed down on the saw by means

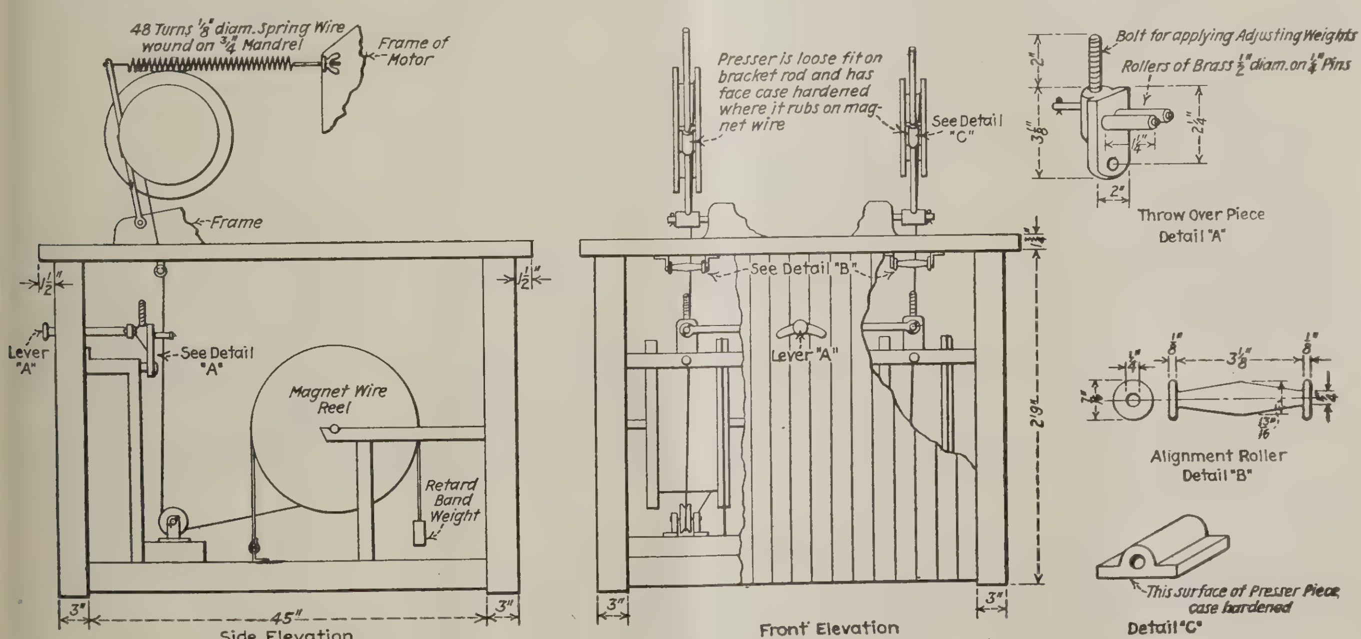


Fig. 4—Construction Details of Field Coil Winding Machine Shown in Fig. 5

of the handle shown at front to which it is pivoted by means of two cap screws, one each side.

Control of current is obtained through taps to primary winding, and these taps are connected to a switch plate, shown at left of machine. This switch plate is fashioned somewhat after the rheostat face plate used on d. c. apparatus, except that contact pins over which lever arm works, are spaced widely apart with transite blocks between them, so that circuit is completely broken as lever arm is moved.

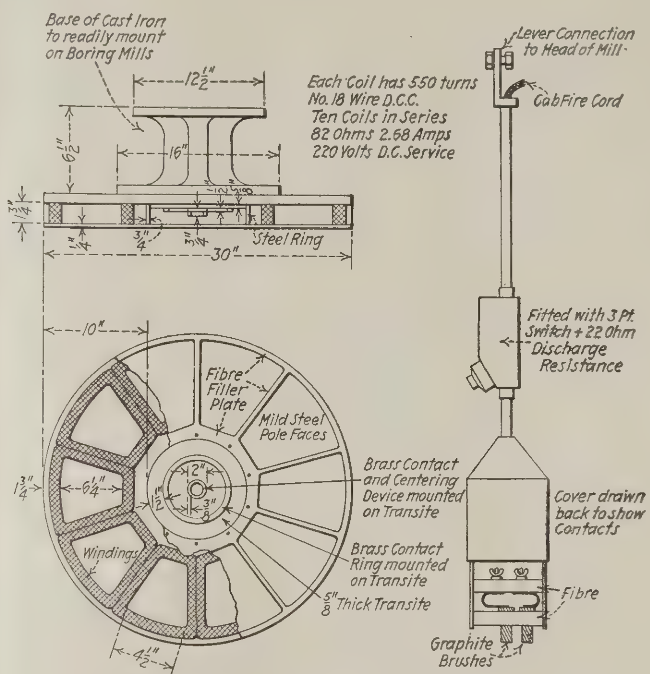


Fig. 3—Sketches Showing Construction of Magnetic Chuck Used in Connection With a Vertical Boring Machine

This prevents short circuiting of any part of primary winding.

Fig. 2 shows dimensions of laminated iron core and particulars of winding used, also the secondary windings to head blocks.

Fig. 3 shows another machine tool made up to trim piston rings. This is a magnetic chuck designed for use on a vertical boring machine. The slip ring system con-

sists of a vertical pipe with rotary switch on it, and a resistance fitted so that when power is shut off from the d. c. 220-volt source of supply the magnet winding is automatically shunted across a discharge resistance, thus taking care of discharge. At the base of pipe will be seen two bars of fibre. The bottom piece has two round holes bored in it, into which are fitted two rivet shaped brushes of graphite, and the compression on them is obtained by means of two phosphor bronze leaf springs, which are mounted on the top bar of fibre to which is connected the mains from the switch.

The magnetic chuck has a centre contact of brass, which is counter bored, and into which the centre brush fits, automatically holding the brush system central. There is

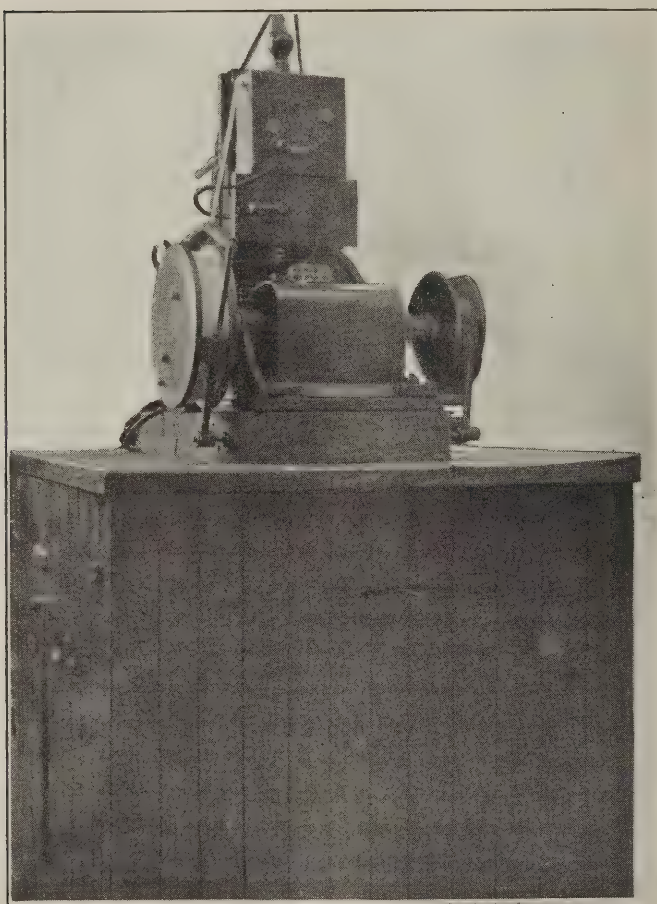


Fig. 5—Field Coil Winding Machine. Reels of Magnet Wire Are Mounted Inside the Base and Are Completely Covered

a contact ring of brass around the centre contact but insulated from it, on which the other brush rests.

This magnetic chuck has been very successful, and has been in use for some eighteen months, during which time it has effected considerable savings in the particular work it accomplishes.

Each ring is drilled beforehand at the split and the hole fits over a small peg (not shown) in the chuck, thus preventing slippage.

The real value in this device is that a perfect (from a machinist's point of view) flat surface is provided to which the ring must conform due to the tractive effect of the magnetism. Practically all sizes of our Locomotive type piston and valve rings can be handled on this chuck. Holes for pegs to suit the different sized rings are provided.

Coil Winder

Figs. 4 and 5 show a shop made machine for winding *K* and *E* field coils for Pyle Headlight generators. It operates at a speed of 120 r.p.m. Its chief point of merit is the automatic wire laying arrangement which does a really excellent job. The sketch, Fig. 4, shows how this is accomplished. Lever "A" is thrown over at the end of each layer to the side that the new layer starts from. The coil forms are made of cast iron, and the shunt winding is wound as a split ring which fits inside the form used for the series winding, thus four different coils are handled on this machine. The lever "A" throws over automatically on the larger sizes of wire, but for No. 18 and smaller it was found advantageous to provide a small handle in front to throw same over by hand.

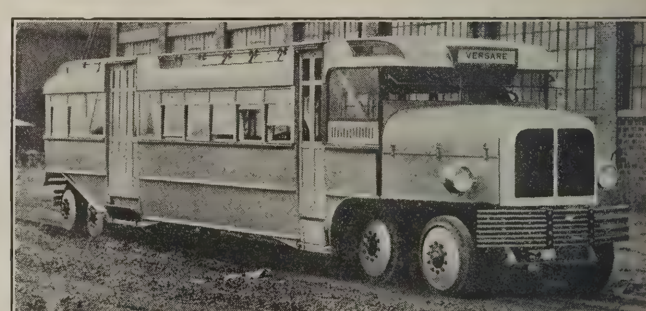
This machine has proved of considerable value since being put into service in turning out a constant uniform product and in turning out or in being the means of turning out an article at a low cost.

A Heavy Highway Car for Railroad Use

The Versare Corporation, Albany, N. Y., has perfected a highway passenger automobile which moves on two four-wheel trucks and will seat 44 passengers with standing room for 52 more. Its drive is gas-electric. Both pairs of trucks are movable as are also, separately from the trucks, the front pair of wheels of each.

The corporation does not propose to sell these vehicles to the competitors of the railways. It expects to find a market rather with the steam railroads and the street railways which, it is believed, can use the vehicle to supplement existing services. A freight truck of the same general design is being built and will be ready for test in about a month. It will carry a paying load of 15 tons, and will likewise be sold only to railways.

The present coach has eight springs which absorb the road shocks and reduce the pounding effect on the road and shocks to the body and chassis, making for longer



View of Coach from Right Side Showing Doors

life of the mechanism and improving riding qualities. It has an overall length of 40 ft. and is mounted on 30-in. wheels that are provided with rubber cushion tires. The trucks have a wheel base of 54 in. The distance from center to center of trucks is 30 ft. The total weight of the vehicle is 16,000 lb. The tread is 61 in. and the body width 8 ft., the latter being the maximum allowable by law. It is possible to turn this vehicle around in a circle with a diameter only 5 feet greater than its length.

The trucks are of swivel type. The driver controls the

front wheels of the forward truck by means of a steering wheel in much the same manner as the ordinary automobile and the rear truck tracks with the forward truck automatically.

Traction is secured by motors which obtain their power from a generator which is driven by a gasoline motor. The elaborate mechanism with many differentials and universal joints which would be necessary for mechanical transmission on such a large vehicle is thus avoided, as is all gear shifting. This is considered an important advantage, in view of the fact that heavy vehicles in frequent stop service requiring much shifting of gears are apt to be laid up frequently because of transmission troubles. The electric transmission also has the advantage of reducing vibration, which makes for lower maintenance costs and the smooth acceleration which makes for more comfortable riding. The engine is also used more economically.

This coach is equipped with a 100-hp. engine recently developed by the Waukesha Engine Company. This engine is a model 6-A, with 4½-in. bore and 5¾-in stroke, constructed with the Ricardo head. This engine is connected to the generator by means of a flexible coupling and the two are mounted as a unit on channels lengthwise of the car as in ordinary automobile practice. The driver's seat is to the left of the generator that is connected to the rear of the engine.

The electrical equipment for the Versare coach was supplied by the Westinghouse Electric & Manufacturing Company. The generator is capable of utilizing the full output of the engine and is able, without overheating, to supply full power to the two motors.

The motors have a rating of 20 hp. at 175 volts. There are two of these, one mounted on the rear axle of each truck. They are of vehicle type, rated at 20 hp. and have a high continuous rating. They are partially enclosed to protect the commutator against dirt and water.

The master controller and a braking controller form the principal parts of the control apparatus. The master controller has three operating positions, series and parallel forward and parallel reverse. The parallel operating position forward is the first position from the "off" as it is used more frequently than the series. The master controller is mounted directly under the driver's seat and a level for positioning the controller extends up through the seat to the left of the driver. A special notching device is provided on the lever that protects the control from rough handling by the driver.

The type of control is simple in operation and easily mastered. The engine is first started, of course, as in ordinary practice. The driver then throws the motor control lever into one of the operating positions. He is then ready to go. The engine throttle is practically the only control regularly used, the variations in engine speed being sufficient to produce the desired voltages and hence coach operating speeds.

This coach is provided with three independent sets of brakes. Standard automotive Westinghouse air brakes, of the internal expanding type, are provided on all eight wheels with the usual controlling air drums. In addition to the air brakes, the hand brake is incorporated on the truck for bringing the coach to a stop or for holding it for long periods. The hand brake lever is mounted on the left of the driver. In addition to these two brakes, the electrical brakes are incorporated in the electrical scheme of control. It will thus be seen that the braking requirements have been carefully met.

The air storage tanks, the electrical grid resistance and a 40-gal. gasoline tank are all mounted under the center of the coach. Air is supplied to the tank by means of a compressor directly connected to the engine. These tanks clear the side of the coach and in no way interfere with clearances needed for ordinary operation.

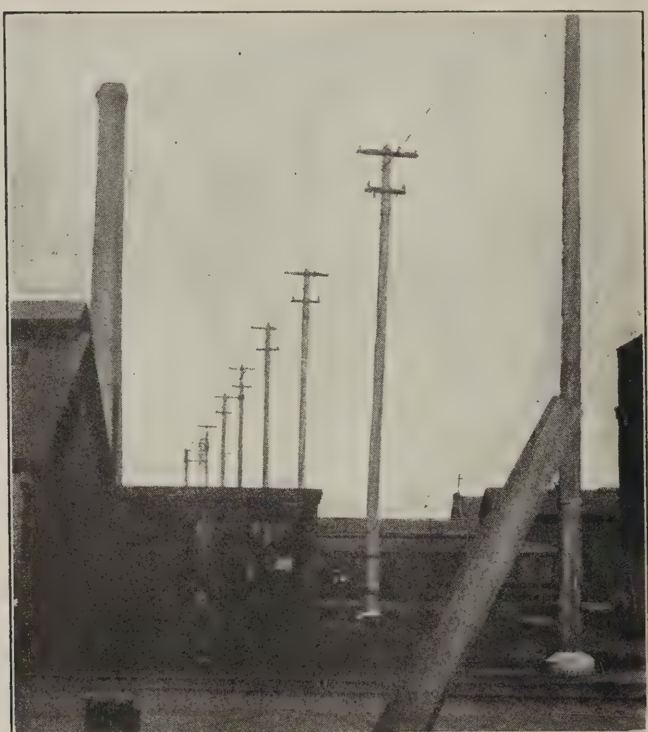
Coach Turning Back on a V-Shaped Street Intersection—Both Trucks Have Turned as Have Front Wheels of Each Truck

Electrification on Illinois Central in Chicago Suburban Zone Nearing Completion

St. Paul Power Plant Shows $70,000 Saving

Turbine Installation at Milwaukee Permits Shutting Down Old Reciprocating Plant and Furnishes Better Service

A REDUCTION of 24 employees and a saving of approximately 700 tons of coal a month, wich have been thus far realized as a result of changes made in the power supply at the Milwaukee, Wis., shops of the Chicago, Milwaukee & St. Paul, indicate that an annual saving, in labor and fuel alone, of $70,000 may be expected. This is in addition to certain intangible savings



Transmission Line Which Connects the Two Plants. All Poles are Set in Concrete

brought about through having an ample supply of power at all times. The turbo-generator unit responsible for this creditable preformance has only been in operation since May 1, and was installed to furnish power to the entire plant which includes both locomotive and car shops.

Formerly the electrical power requirements of the shops were met by four 200-k.w Nordberg-Corliss engine gerator units and three 100-k.w. Westinghouse vertical units installed in the so-called main power plant on the locomotive side. In addition a 400-k.w. Vilter-Corliss engine generator unit was installed in a second plant on the car side. These units were installed from time to time to meet the normal increase in demand and represented anything but economical operation. Furthermore, there was always a shortage of power and a shortage of compressed air with the result that the existing units were operated almost continuously at an overload.

2,000 Kw. Turbine Handles the Day Load

About a year ago a study was completed and authority granted for moderizing the power plants at these shops. As a result a 2,000-kw., 2,300-volt, 3-phase Allis Chalmers turbo-generator unit was purchased for installation in the main power plant. Since the motor equipment throughout the shops was of a direct current type, provision had to be made to convert the alternating current into direct current for distribution. The study indicated that the electrical load center and also the load center of the air supply conformed closely to the power plant on the car department side. It was found after deducting the lighting load that the demand for direct current would be about 1,000 kilowatts with occasional peaks as high as 1,200 to 1,400 kilowatts. It was, therefore, decided to install two 500-kw. synchronous motor-generator sets in an addition to the existing car department plant building. These have a 25 per cent overload rating for two hours. A 5,000 cu. ft. per min. motor-driven air compressor was also installed in the same building with an after-cooler and air reservoir in the open, adjacent to the new substation building.

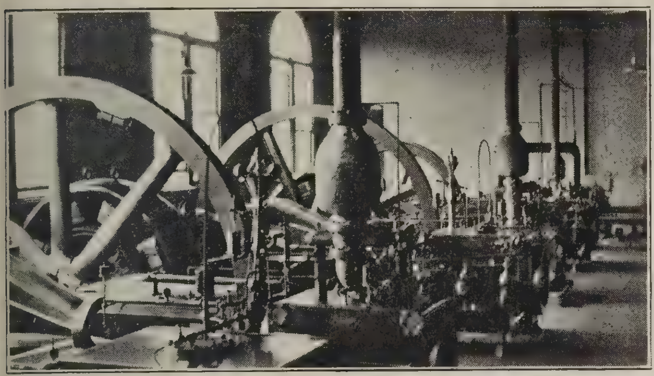
The boiler room in the main plant, which has a capacity of 3,200 b.h.p., is equipped with water tube boilers,

Corner Pole Construction

stoker fired. The only changes in this boiler room were the addition of individual flow meters and soot blowers.

The 2,000 kw. turbo unit is of the bleeder type to furnish steam for heating purposes when occasion demands. It is designed to operate condensing saturated steam at a nominal pressure of 140 lb. at the throttle. The unit has a direct-connected exciter on the generator end of the shaft. This unit is installed on an elevated foundation to provide headroom for the condenser, which is of the jet type and installed immediately beneath the turbine,

The original layout of the plant included a concrete-lined pool approximately 150 ft. from the end of the power house building. A cooling tower was constructed over this pool for use in conjunction with the condensing arrangement. Experience since the installation was completed shows that a vacuum of 26½ in. can be maintained, even with an outdoor temperature of 90 deg. Fahrenheit. It is believed that by slight alterations to the tower

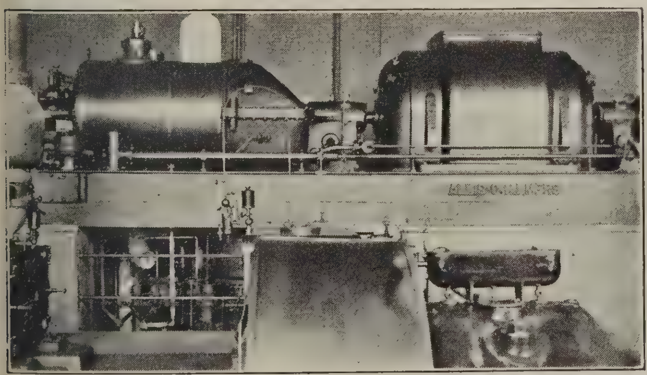


Some of the Engine Generator Units in the Main Power Plant

this vacuum can be raised with even the highest summer temperature. No trouble is experienced in maintaining at 28 in. vacuum when the outdoor temperature is as high as 75 deg.

An interesting feature of this installation is the manner of handling the distributing lines. Normally the turbine unit is operated only during the day shift; the demands for electrical power during the remaining two shifts not being of sufficient amount to warrant operating the turbine. During these shifts the engine-driven units are operated to supply the demand. With this arrangement, and to provide a stand-by service as well, it was necessary that the distribution layout be such as to be supplied from either plant, either independently or working in parallel.

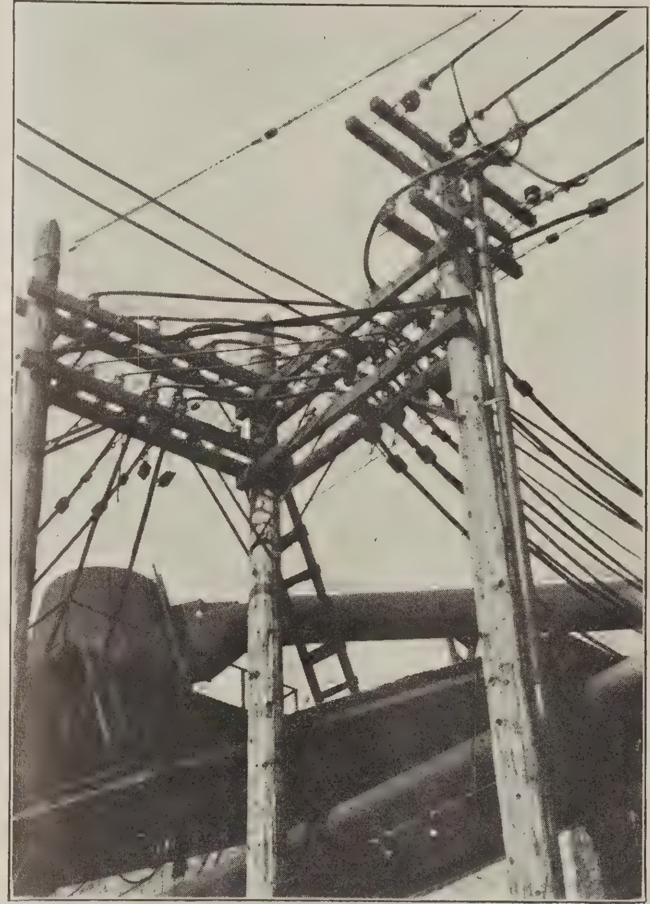
The 3-phase, 2,300-volt power supply is transmitted



The Turbine is Installed on an Elevated Foundation to Provide Head Room for the Condenser

from the turbo unit in the main plant by a pole line approximately 2,000 ft. in length, connecting the two plants, this line being protected at both ends with choke coils and lightning arresters. On this pole line a direct current circuit consisting of two 1,300,000 circular mil cables was installed, connecting the direct current busses of the two plants. This arrangement permits of parallel operation, but the primary source of supply is, of course, from the turbine and motor-generator sets. By placing the motor-generator sets at the load center a large amount of feeder copper has been reclaimed and better voltage regulation provided at the load than was formerly the case.

The switchboard arrangement in the main power house was not disturbed, other than was necessary through the rearrangement of the feeder line. An additional panel was installed separate from the direct current board for control of the turbo unit and transmission line. In the substation, in addition to panels for control of the motor-generator sets, the air compressor and the transmission line, 11 feeder panels, with one feeder per panel, were installed. Formerly in the car department plant a



Special Junction Pole Construction Used to Carry the Heavy Feeders at the Substation

small steam engine-driven generator unit was installed to supply current for battery charging and for testing out lighting in the cars being shopped. This unit was replaced with a small a.c. motor-generator set and control panel which was installed in the new substation.

It is the plan eventually to change all of the lighting throughout the shops at 220 volts, a.c. This has not yet been accomplished but the turbo unit is capable of furnishing an additional 300 kilowatts for this purpose.

Compressed air is furnished for the two shifts when the turbo unit is shut down, by a steam-driven compressor unit in the main power plant. This compressor may also be used to help the large motor-driven compressor in case of an exceptionally heavy demand.

The plant has been operating with the new arrangement since approximately May 1, and has already resulted in reducing the payroll by 24 employers and the fuel consumption of the two plants has been reduced by approximately 700 tons a month. The operation up to the present has been entirely in the summer months, but the saving thus far realized indicates that an annual saving in direct labor and fuel of $70,000 may be expected. The intangible savings through having an ample supply of electric power and compressed air are practically indeterminate, but that they constitute a sizable item cannot be questioned. In the old power plant it was not infrequent to have a voltage of less than 200 at some of the motors, while the air pressure frequently dropped to 65 or 70 lb. With the new plant under average load conditions the voltage at the most isolated motor is not below 215 and no difficulty is experienced in maintaining a pressure of 95 lb. on the air lines. During the winter the saving in labor will not be so great, as the boilers on the car side will have to be operated for heating purposes, requiring one additional fireman per shift. A watchman is also maintained in the car department plant during the night to shut off the air lines when the air is not required and as a protection against fire.

Welding in Railroad Shop Practice

Equipment and Methods Used in Santa Fe Shops at Albuquerque, N. M., Insure Dependable Work

WELDING practices employed in the Santa Fe shops at Albuquerque, N. M., are probably as good a representation of best railroad practice as can be found. The shops were built about two years ago and accordingly the equipment used is for the most part new. On the other hand two years have elapsed since it was installed and in this time means have been devised for using the equipment to best advantage.

The shops include roundhouse, car shop and back shop.

Welding Shop in the Car Department Showing the Preheating Forge, Horses for Supporting the Castings and the Annealing Furnace

The back shop is now turning out something over 300 classified repairs a year and normal annual output of the car shop is 1,200 heavy car repairs.

Equipment

Both the gas and electric process are used, the gas being used for welding and cutting, the electric for welding only. The electric arc welding equipment consists of six portable electric welding machines in back shop, two in roundhouse and one stationary type in welding shop, which furnishes current for four operators.

The flue welding shop is equipped with one small and one large electric flash or butt welding machine, the small machine being used for safe ending flues from two inch to two and one-quarter inch diameter; the large machine is used for all flues of larger sizes.

There are also two portable electric arc welding machines in use at the car department for welding of car castings.

All car repair work is done in the car shop or yard. Small locomotive parts that can be moved easily are taken to the welding repair shop and the welding of large parts is done in the back shop.

The car shop, roundhouse and back shop are piped for both acetylene and oxygen. The acetylene is carried at a pressure of from 7 to 8 oz. in a 4-in. line with smaller laterals. A 2-in. line and a pressure of 55 lb. is used for the oxygen. The oxygen is purchased in cylinders. A number of cylinders, connected through a manifold, supply oxygen to the pipe line. Practically all of the acetylene is generated in a small generating plant in the shop and supplied to the pipe line from this plant. A few cylinders of acetylene are kept on hand for use on a portable outfit that can be taken to outlying points.

In the locomotive department there are about 200 gas stations or outlets and there are 87 on the repair tracks and in the car shed. On the erecting floor the gas stations are located in the pits and on the machine side they are placed on the columns. The welding and cutting torches are fitted with 50-ft. hoses.

The electric welding sets are operating from a 230-volt direct current circuit in the back shop and roundhouse and from a 440-volt, 3 phase alternating current circuit in the car shop. On the erecting and machine tool floors the welding outlets are located on the columns about 6 ft. above the floor. The receptacles have an interlocking mechanism so arranged that the plug cannot be inserted or removed from the receptacle unless the switch is open. These outlets are also used for the operation of portable lathes and motor driven cylinder boring bars.

The motor of each welding set is provided with a six foot lead or armored cable and a plug for connecting to the power supply outlets. The lead is made short so that the set must be close to the column when it is connected and cannot be set so as to obstruct the aisles. The gen-

erators are provided with cambric insulated, braid covered welding leads from 50 to 70 feet long.

Car Department Welding

Welding has been applied to the work of the car department on a large scale with surprising results. The bulk of the work done consists of welding cracked truck side frames, truck bolsters and body bolsters in accordance with A. R. A. rule 23.

The sections to be welded are first inspected to determine whether or not the fractures are within the welding limits. Before a weld is made the piece is cleaned with

A Sample of Welding in the Boiler Shop, Showing the Method Used for Grounding One Side of the Electric Welding Circuit

a sand blast. The crack is V'd out with the cutting torch and the slag chipped off with a cold chisel and hammer. The weld is then made either with the electric arc or the gas welding torch.

When the torch is used, the member to be welded is placed over a pre-heating forge with the ends of the section on horses. The horses were built by the welding process from 3-in. pipe. The forge is made of a piece of 24-in. pipe about 20 in. long. About 6 in. from the lower end there is a circular grate with a piece of ¼ in. pipe projecting through the center. The pipe is supplied with air from the shop air line and the amount of blast is regulated by a valve just outside the forge. The forge burns coke and is used to heat the part of the casting on which the weld is made. This procedure has been found to improve the character of the weld and to reduce the amount of gas required to make the weld.

After the weld is made the casting is picked up by a 1½-ton chain hoist on a post crane and placed in an annealing furnace. The furnace has a capacity of four castings and burns oil. The castings are heated to a temperature of from 1,400 to 1,500 deg. F. after which they are removed and allowed to cool. They are then given a final inspection and replaced in service. All truck side frames and bolsters which are welded are marked to show the shop in which the weld was made, the operator who did the work and the date the work was done. Thus AQ-6-3-5-25 would signify that the work has been done at Albuquerque by welder No. 6 on the fifth of March, 1925.

The normal output of the car shop is about 100 cars per month. The savings effected by welding in this department alone, not considering scrap value, have been shown to be $6,000 a month. The welding is done by gas and 2 electric operators.

Locomotive Department Welding

The work done by the locomotive department has so many ramifications that it would be difficult just to make a list of the jobs done. For this reason only a few of the outstanding or unusual jobs are mentioned here.

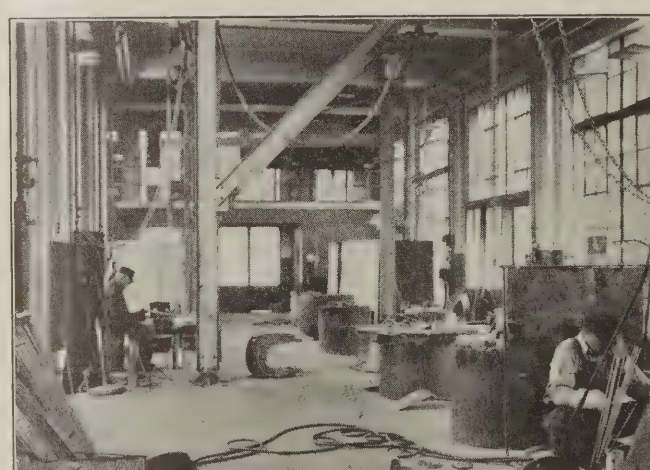
The method of applying shields to superheater units or tubes, is one operation which has proven to be highly profitable. There are two places in the curved-up ends of the tubes where they are cut by cinders. To prevent damage from this source a piece of No. 14 or No. 16 steel plate is formed so as to fit the outside of the tube, and is placed over the section that is subjected to wear. It is held in position by four tack welds at the corners. The protecting plates are formed in a die, operated by an air cylinder.

The feed and elevator screws on stokers when worn by the action of the coal are built up by either the gas or electric process. After the edge of the screw has been built up it is left rough as welded. The welded edge is sufficiently accurate for the purpose and the surface of the weld withstands the action of the coal effectively. Stoker rack teeth are replaced with electric welding and machined after welding.

These and many others can be cited as examples of the importance of welding in the locomotive department.

Welding Shop

Portable locomotive parts which require welding are taken to the welding shop. It is housed in a one-story building, 30 ft. wide by 90 ft. long. There are ten gas stations in the building and four electric welding outlets. Current for electric welding is supplied by a four-operator stationary welder mounted on a platform or balcony



The Welding Shop

at one end of the shop. Polarized battery charging receptacles are used as welding outlets and 50 ft. welding leads and shop-made electrode holders are used.

The shop is also equipped with three coke-burning, preheating furnaces, two 1½-ton and two 3-ton air operated jib hoists, six welding tables, a heavy vise, a cutting table and an exhaust hood for brass welding. The welding tables are 22-in. high and have legs made of 3-in. pipe. Originally the tops of these tables were covered with fire brick, but a piece of ¾ in. boiler plate was found to be a more satisfactory top and a piece has been laid on top of the brick on each table. The cutting table con-

sists of a large iron kettle across the top of which have been placed several pieces of scrap boiler plate so as to form a sort of grill on which the material to be cut is placed.

Testing Operators

In order that officials in charge of welding and the welders themselves may know what kind of welding is being done from month to month, it is the practice of the Sante Fe Railway to have each welder furnish a test plate monthly. The manner in which this plate is made and tested was described recently in a paper by E. E. Chapman, engineer of tests and H. H. Service, supervisor of welding equipment, presented before the Chicago section of the American Welding Society. The procedure is as follows:

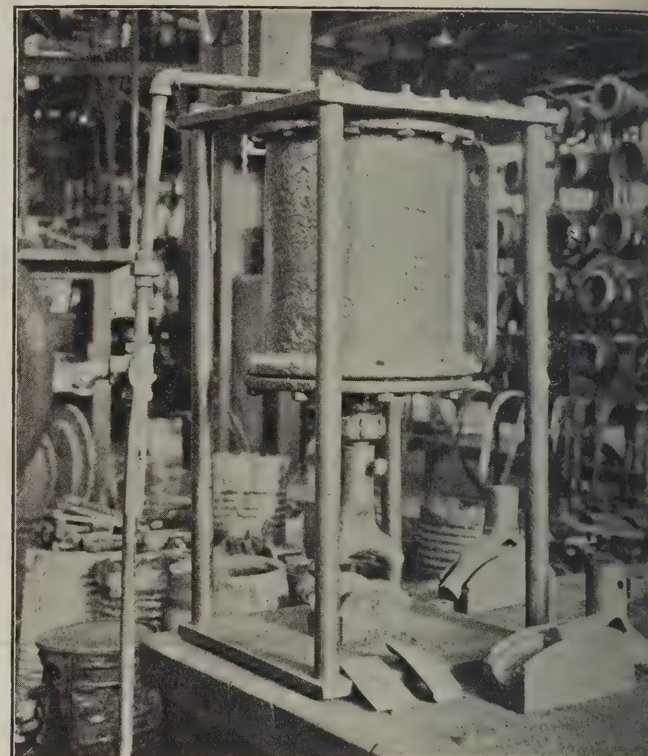
Secure two pieces of boiler steel 3/8 x 2½ x 9 in., bevel one end of each to form a 90 deg. angle between them, place the two plates in a convenient position for welding with 3/16 in. opening at the bottom of the "V" and make the weld from the top side only, reinforced a maximum of 20 per cent over stock size on one side only, if welder desires this much reinforcement to produce the best weld he is able to make.

It will be noted that in this test plate the weld is allowed to be reinforced 20 per cent over stock size, more than that is milled or ground off, and plate to be welded only from one side, in order that the welder can approx-

Some Reinforced Superheater Units

imate the condition of welding a side sheet or its equivalent in a firebox. The welder is instructed not to forward any weld for test unless he is satisfied that it is the best he can make, and representative of the work he does. These welders are then rated according to the percentage strength of their welds which is based on the thickness of the original stock, and an ultimate strength of 60,000 lb. per square inch. It is the desire to have welders stimulate actual working conditions as nearly as possible, and it is also endeavored by the foreman to have the welder complete his work at the original heat and avoid the plastering over of metal incident to reworking and consequent weakening of the original weld. From the test data thus obtained the foreman has sufficient information at hand to judge the welder's ability to produce good work and it will justify him taking proper steps for keeping the welding up to a high standard by correcting the faults or assigning only the men who are able to make satisfactory welds to the more important welding operations.

Tests have also been made to determine the relative efficiency of welded specimens to the original stock, under vibration or alternate bending, but this is a comparative



Press and Dies for Forming Superheater Reinforcing Plates

proposition and not one that can be used as a regular control.

Welding Efficiency

An analysis was made of specimens tested for the years 1920 and 1921 to show the average efficiency of welds produced by welders having different years of welding service and the results are shown in Table I.

TABLE I

Years service as welder	Welded specimens tested		*Efficiency of weld-per cent	
	Gas	Electric	Gas	Electric
Less than one	195	147	75.8	90.6
One	93	81	89.2	93.2
Two	177	131	85.8	92.9
Three	78	72	84.4	95.2
Four	47	10	90.6	96.9
Five	27	..	96.7	....
Six	4	6	98.3	101.0
Seven	3	9	74.6	94.9
Eight	16	..	82.4	....
Nine	7	..	89.6	....
Total	647	456	Ave. 86.7	95.0

*These efficiencies are values based on a tensile strength of 52,000 lb. per sq. in., the minimum value allotted in specifications for firebox steel.

It is noted that for the seven and eight years welding service the value showed a great deal below the average which was due to a poor welder working in these two groups, but the indications are that the longer the service the greater the skill shown by operators. It will also be noted from this tabulation that for strength alone the electric welding shows up better than the oxyacetylene

welding. However, for the year 1923, a check of this relation shows that due to improvement of the kind of metal used for welding with oxyacetylene the results of the latter are about on a par with the electric welding for strength.

The results obtained in four of the largest shops and in four of the largest roundhouses of the system are shown for the last three months of the year, October, November and December, 1924, in Table II.

It will be seen from these figures that a butt welded seam with a maximum reinforcement of 20 per cent of stock averages well above the 45 or 50 per cent efficiency allowed for single riveted seams.

From this it will be seen that the railway management

A Pile of Truck Side Frames, Truck Bolsters and Body Bolsters Reclaimed by Welding

exercises a systematic control over autogenous welding operations, especially as it concerns the welding of boiler and tank steel plates. This, of course, is only one phase of the rather extensive use of these welding methods and the periodic control can easily be exercised, but there is a

TABLE II

Shops	Welded specimens number tested Gas	Welded specimens number tested Elec.	*Specimens broken outside of weld, per cent Gas	*Specimens broken outside of weld, per cent Elec.	†Efficiency, per cent specimens broken in weld — Gas Min.	Gas Ave.	Electric Min.	Electric Ave.
Topeka	29	46	24	24	77	101	75	96
Albuquerque	63	32	62	53	57	99	75	101
San Bernardino	31	34	45	38	84	104	88	104
Cleburne	16	9	63	33	68	90	83	98
Total	139	121	..	..	..	..	..	..
Minimum	..	..	..	..	57	..	75	..
Average	..	..	50	37	..	98	..	99
Roundhouses								
Winslow	9	9	56	33	101	108	98	105
Amarillo	8	8	75	75	103	103	78	89
Newton	22	32	46	22	80	99	88	100
Shopton	25	22	52	36	83	98	79	103
Total	64	71	..	..	..	..	..	..
Minimum	..	..	..	..	80	..	78	..
Average	..	..	53	34	..	100	..	101

*This column also includes welds which showed 60,000 lb. per sq. in. tensile strength.

†Efficiency based on firebox steel, 52,000 lb. per sq. in. minimum tensile strength.

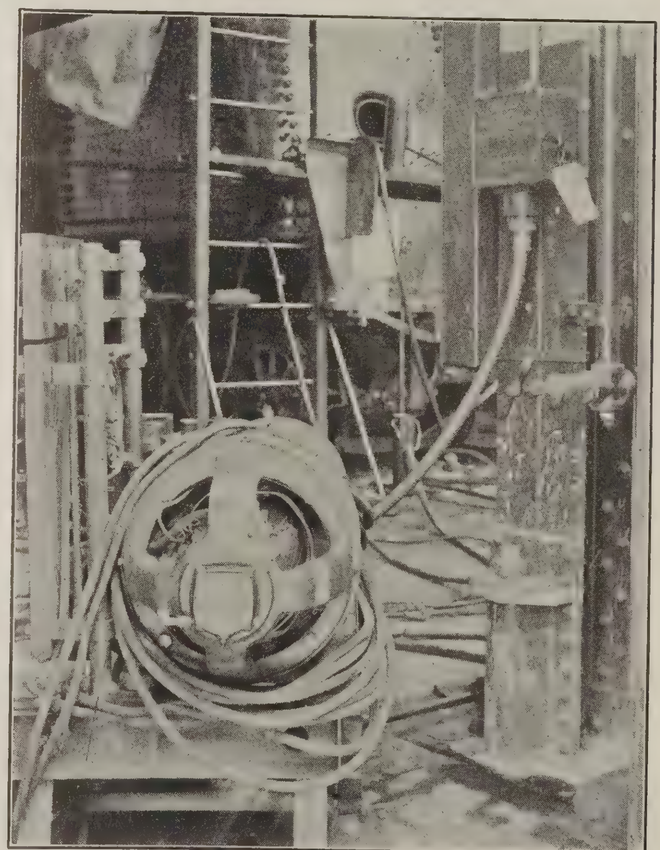
very extensive amount of work where such control cannot be so applied. Problems, such as best procedure and method of welding locomotive frames, bolsters, couplers, cylinders, where heating and subsequent annealing are required, and many similar questions require careful service observations or comparative tests the question arises as to whether it is practical to weld certain kinds of material, whether hot or cold, whether to use cast iron or steel rods for welding material, and with such questions raised many tests have been conducted to increase the list of "Don'ts," for anything not prohibited is assumed to be permissible.

Material Used

Norway iron welding rods are used for plugging holes and building up worn castings and steel rods are used for all work requiring high tensile strength. Steel electrodes are used for welding fire boxes, building up spots on locomotive frames and all steel castings, etc. Steel electrodes are also used for fire box work flues and for welding broken locomotive frames. Pure iron electrodes are used for flues and flexible stay bolt sleeves, etc. Tobin bronze is used for air pumps, and some cylinder work, but is not always used for repairing broken cast iron castings. Manganese bronze is used for building up rod brasses, galled places on main rods and worn spots on cross heads. Work that cannot be machined is ground down and finished with portable air driven grinders.

Welding Instructions

Data on new classes of work have been carefully compiled by the supervisor of welding equipment and in com-



One of the Portable Arc Welders in Service

pliance with instructions from J. Purcell, assistant to the vice president in charge of mechanical matters, these data were issued as a standard pamphlet, designated "Oxyacetylene and Electric Arc Welding Folio," for the instruction and guidance of those who have direct supervision of welding in the various shops and roundhouses on the system. This welding folio is kept up to date by frequent revisions and as better methods are devised and better welding materials are developed, and tried out with satisfactory results, they are included in the folio.

A Handy Bearing Puller

By W. W. Miller, Electrician,
Norfolk Southern R. R. Shops, New Bern, N. C.

In order to remove easily bearings from various types of motors and generators, a device of some kind is needed to provide the necessary pull as such bearings usually fit tightly. The bearing puller shown in the illustration is a shop made affair and has been used with entire satisfaction on motors and generators of various kinds.

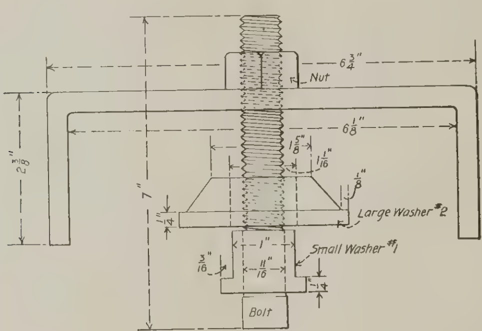


Fig. 1.—General Dimensions of the Bearing Puller

The device is made from a piece of iron 5/16 in. thick, 2½ in. wide and 10 in. long. This iron is bent into a U-shape form as shown. Before bending, however, a hole 11/16 in. in diameter should be bored in the center of the strip to accommodate a ⅝ in. bolt which may be any length desired. The bends in the piece are made 3 in. from the center and the resulting legs are 2 in. long.

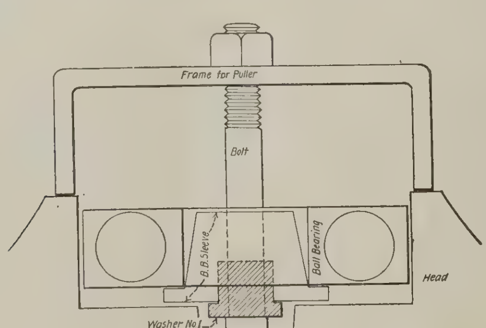


Fig. 2.—Puller As Applied to Small Bearing with Sleeve

To complete the tool, two washers are required, one large washer and one small one. The small washer is so made as to fit into the large washer as shown in Fig. 1 where the general dimensions are given.

The small washer is marked No. 1. It is 1⅜ in. in diameter at the large end and is 1 in. thick. The large end has a flange which is ¼ in. thick with a shoulder 3/16 in. wide. This leaves the sleeve of the washer 1 in. in diameter and through this is drilled a 11/16 in. hole. This small washer is used to pull out bearings with small openings such as the bearings with an inside sleeve as is used in the U. S. L. machines on the commutator end and other machines that have small openings in bearings.

The large washer is marked No. 2. It is 2⅝ in. in diameter at the top or large end and has a flange which is ¼ in. thick with a ⅛ in. shoulder. This washer is tapered down to 1⅝ in. at the small end. The over-all thickness is ¾ in. Through the large washer is drilled a 1 1/16 in. hole to accommodate the small washer. The large washer is used to pull out bearings from pulley end heads and bearings with large openings.

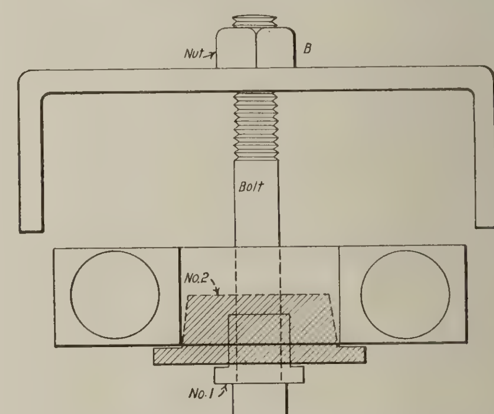


Fig. 3.—Puller Applied to Large Bearing Showing Both Washers in Use

It has been found that this puller will fit any small bearing and large ones too for that matter. I have used it on Safety and U. S. L. generator bearings and shop motors where the bearings fit tightly in the head.

His Bump of Knowledge

Phrenologist (examining Conductor's head)—This bump shows you are very curious.

Conductor—That's right. I was sticking my head into the shaft to see if the dumb waiter was coming up and it wasn't.

Pullman Life

For thirty long and restless years, I've shipped about with other steers: With goats and swine and sheep. Four thousand times, I've took a nap, in Mother Pullman's lumpy lap and grabbed what she *calls* sleep. . . . . I've been stewed and broiled and froze, slept *à la nude* and in my clothes, been shaken, bumped and mauled: have hit the grit about half dressed and on the platform donned the rest, because I wasn't called. . . . . I've peeled myself in an upper berth, while a pig below with ponderous girth, did gurgle, snort and snore: I've felt a mad insane desire, the tool-box ax to then acquire and smear the car with gore. . . . . I've watched some "walrus" wash his face and splatter up the entire place, with water, soap and suds; I've cussed some boob in language neat, who cluttered up the one long seat, with duffle, grips and duds. . . . .

There's one thing though to compensate, these other things which aggravate: our souls (ere we retire). For in the "Smoke Box" we can squeeze, 'tween bunioned feet and knobby knees and knowledge there acquire. . . . . Each night the *Board of Strategy* takes things apart so all can see, what makes them run and tick. They settle all the questions great, that stump the nation and the state and do it neat and quick. . . . . Very much to your surprise, this gang can quickly analyze, a subject big and tell you *why*. They'll switch from how to end all wars, to what to buy in motor cars and never bat an eye. . . . . The Big League game is an open book, on which we all can take a look and all the winners pick. They tell each other how to make, synthetic gin that takes the cake and has an *awful* kick. . . . . To them street traffic is duck soup, they know how to clear "the loop"; in any of our towns. They tell of fish which they "have took," from off an ordinary hook, that weighed a hundred pounds. . . . . And when it comes to radio, this bunch *admit* they're in the know; on circuits, logs and tubes: the only place that they don't get, is running still and open yet, for this same class of boobs. . . . . They know where to buy *good* booze, and how to sell gloves, shirts and shoes: their knowledge is immense. They know just what to do, if you have cancer, colds or "flu" and feel like thirty cents. . . . . But when this type of super-man, puts our railroads on the pan, and concentrates his fire: there's two things left for me to do; either whip the whole dam crew, or gracefully retiré.

Oversold

"Fellow-citizens," said the candidate, "I have fought against the Indians. I have often had no bed but the battlefield and no canopy but the sky. I have marched over the frozen ground till every step has been marked with blood."

His story told well, till a dried-up looking voter came to the front.

"I'll be darned if you hain't done enough for your country. Go home and rest. I'll vote for the other fellow."

Education and Liquidation

Conductor—"How is your son getting on at college?"

Engineer—"He must be doing pretty well in languages. I have just paid for three courses: $10 for Latin, $10 for Greek, and $100 for Scotch."

When the Train Was Due

Passenger (to Negro porter while on train for New York)—"What time do we get to New York, George?"

Porter—"We is due to get there at 1:15, unless you has set your watch by eastern time, which would make it 2:15. Then, of co'se, if you is goin' by daylight savings time, it would be 3:15, unless we is an hour an' fifty minutes late—which we is."

He Knew His Father

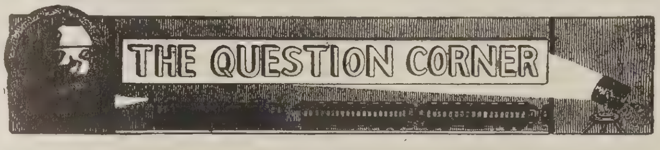
First Little Boy—Johnny, do you believe in the devil?

Johnny—Naw, it's just like Santy Claus, it's your father.

Discretion

Conductor (to his little son)—So the boy next door said you looked like me. And what did you say?

Son (grumpily)—I didn't say nothin'. He's bigger'n I am.



Answers to Questions

1.—*Give a simple explanation of power factor.*

2.—*What is meant by wattless current in an alternating current circuit?*

Power Factor

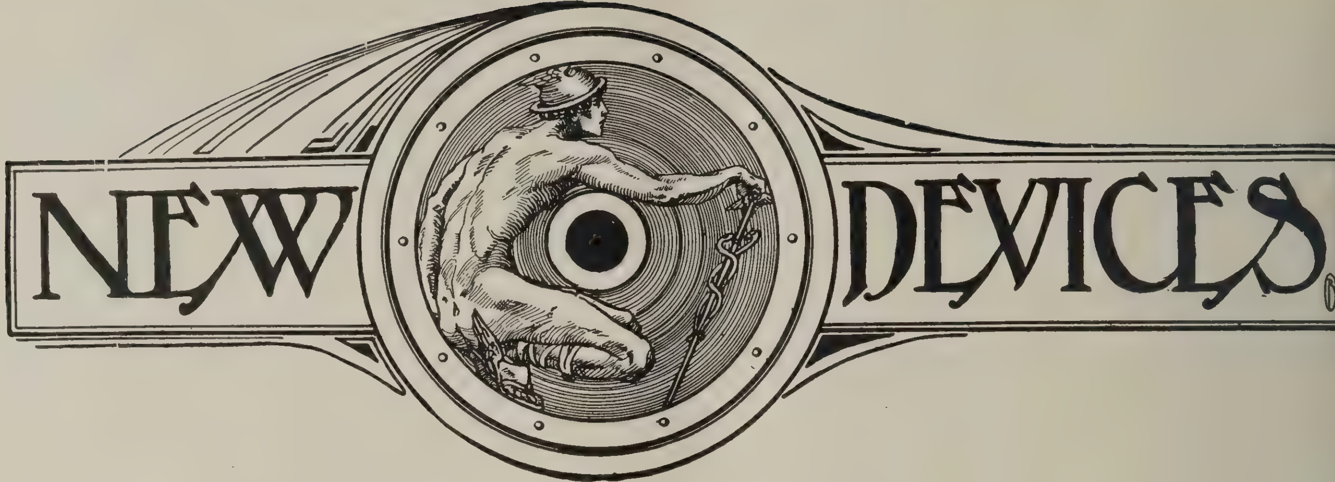
In direct current problems the amount of power developed in a circuit is the product of the current flowing in amperes by the voltage of the generator. This is not always true in the case of alternating current, in fact it is seldom entirely true. The nearest approach to it occurs in alternating circuits where the load is non-inductive as with a lighting load. Usually there is sufficient inductance in an a. c. circuit to cause the current to lag somewhat behind the voltage with a result that the product of the current as measured in amperes and the voltage of the line does not give the true power consumed. The actual term "power factor" is an engineering term referring to the percentage of total current in an a. c. circuit which is being transformed into other forms of energy. It is the ratio between the actual power and the apparent power.

Wattless Current

In practically all alternating current circuits, the devices used require that they be put into magnetized state before they can begin to function and perform useful work. The current which accomplishes this magnetization is not in phase or in step with the voltage and does not directly require the expenditure of any mechanical energy. The magnetizing current is 90 electrical degrees out of step with the voltage and hence having no voltage component it is considered as wattless current.

Questions For September

1.—*In a three wire return loop system, such as is employed on train lines in car lighting work, do all the cars of the train receive the same voltage?*



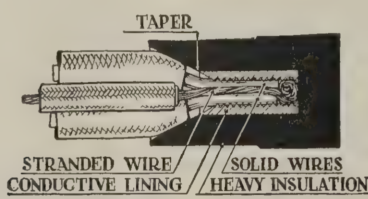
Wires Nuts for Joining Wires

A simple device which takes the place of solder and tape for connecting electrical wires is being marketed by the Tork Company, Inc., New York. It is known as a "wire-nut" and consists simply of a brass sleeve in a molded insulation shell. The brass sleeve has an inside thread and the insulation sleeve is open at one end. This opening is tapered.


Switchbox in Which Wire Nuts Have Been Used for Making Connections

To connect and at the same time insulate a pair of wires, the insulation is first stripped off the ends of the wires, the ends are laid side by side and the wire-nut is screwed over them. The threads in the brass sleeve cut threads on the wires as the nut is screwed into place. It is not necessary to twist the wires before applying the nut. The joint is quickly and easily made and the result is an extremely effective insulated electrical connection.

Diameter of commercial electrical wires of the same gauge vary as much as three-thousandths of an inch and by the use of special threads in the brass inserts or sleeves, all of these variations are taken care of. Exact diameter of the insert is highly important and each one of the millions of nuts manufactured is individually gauged and rejected if it does not fall within the prescribed limits.

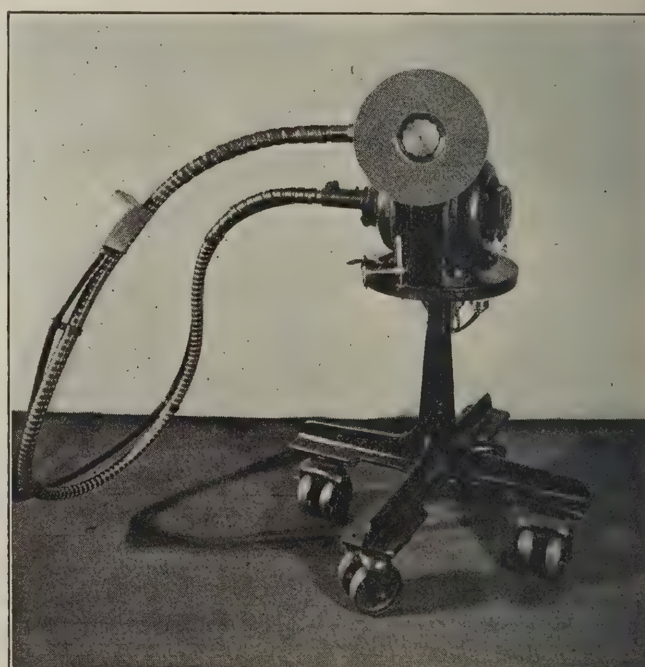


Cross Section of One of the Nuts Showing Two Solid Wires Connected with One Stranded Wire

Stranded wires may also be included in the joints as the wire-nuts do not cut the strands but pack them tightly into the crevices between the solid wires. By simply leaving the stranded wire a little longer than the solid wires, a lock is automatically formed which prevents any of the stranded wires being loosened from the joint. Wire-nuts are packed in cartons of 100 and standard packages of 1,000. They are made in three sizes for 2, 3, and 4, No. 14 gauge, solid wires respectively, or other combinations of equivalent total diameter.

Portable Sanding Machine for Car Repair Work

The usual method of finishing metal parts used on passenger cars is by hand filing and buffing. The Carborundum Company, Niagara Falls, N. Y., have placed on the market a portable sanding machine which takes the place of the hand method of finishing. This machine grinds away the metal with a special flexible abrasive disc driven by a motor through a flexible shaft. The disc is coated with Aloxite grains, a hard, sharp and tough abra-


Flexibility of Control and Operation Are Features of the Carborundum Portable Sanding Machine

sive or grinding material manufactured by the Carborundum Company.

The motor is mounted on a rigid cast iron pedestal, 24 in. high supporting a swivel table providing for a swing of the motor half way around, or an arc of 80 deg. This feature adds greatly to the adaptability of the unit to any required position during the continuous grinding operations. The pedestal is supported by four substantial double castors, permitting ease of movement and travel, without danger of upsetting. A holder mounted on the table provides a secure resting place for the machine head when not in use.

Each machine is equipped with a one-horsepower motor built to such specifications as may be required to meet the power conditions of the user. The flexible shaft which drives the grinder head is of the most modern and approved type, especially adapted to meet heavy duty conditions. The main castings of the grinding head are of aluminum to insure lightness plus requisite strength and durability.

The assembly shafts and spindles are of steel, supported in ball bearings, reducing friction to a minimum. Heat treated, specially tempered steel mitre gears running in an oil-tight chamber packed with grease provide the angular drive from the flexible shaft. Ample facilities are arranged for the proper lubrication of all moving parts.

The grinding head is designed to be perfectly balanced and the driving mechanism is so planned and constructed as to eliminate vibration. The head is provided with two handles which are located to insure accurate control and convenience in operation.

The Aloxite grains with which the discs are coated are uniformly graded and are coated on the discs in such a way as to allow for a free cutting action. There is a definite clearance between the grains so that every grain has full cutting capacity. The grains are coated on a strong, durable backing of cloth drills. This cloth-backed disc is then securely fixed to a special fibre board disc with a moulded, counter-sunk center provided with six pin holes which locate over the pins in the special lock nut that holds the disc securely to the head. These discs are furnished in a standard size of 9¼ in. in diameter.

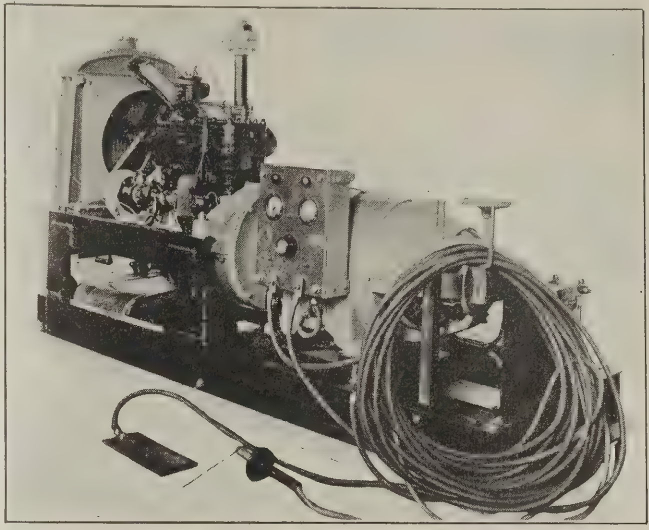
Flexibility is another important feature in connection with the discs and the grinding head. Evenly supporting the disc is a flexible and compressible pad which yields to the slightest pressure, thus conforming to work projections. This feature together with the flexibility of the discs itself permits the disc to conform readily to mouldings, beadings, sharp curves and contours, even under light pressure.

Engine Driven Welding Set

A new engine driven welding set has recently been added to the General Electric line of welding equipment. This outfit consists of a standard WD-12 welding generator driven by a Buda engine, all mounted on wooden skids to facilitate moving from place to place.

The engine is a Buda model WTU, especially designed for heavy duty. It is a four cylinder, four cycle machine of the "L" head type, with 3¾ inch bore and 5⅛ inch stroke. The S. A. E. rating is 22.5 horsepower, and at 1400 r. p. m. the actual brake horsepower is 33.

The new outfit is being marketed complete with all accessories and ready for use. This unit should be of value in railroad repair work, in the construction of pipe lines



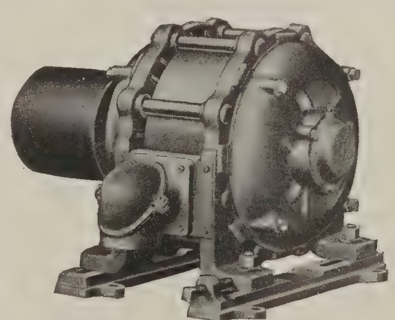
200-Ampere Continuous Rated Arc Welding Generator Driven by a 20 Hp. Buda Gas Engine. Set Is Shown Complete With All Accessories

and tanks, in ship repairs, either at the dock or by welding barge, or on any construction job where electric power is not available.

Ball Bearing Motor With Magnetic Starter

The U. S. Electrical Manufacturing Co., Los Angeles, Cal., has developed an automatic-start motor, which accomplishes magnetically what is ordinarily done mechanically. It is a simple squirrel-cage motor with a rotor, so designed that when the current is first thrown on it is carried in part of the cage until the motor attains its speed, when through magnetic action the complete squirrel cage takes the load.

The motor starts across the line with full voltage. The manufacturer states that full speed is attained in 25



U. S. Electrical Manufacturing Company Motor with Built-in Starting Device

per cent less time than with a motor started with a compensator. The starting principle incorporated into this motor does away with many moving parts. The motor has a high starting torque. The current taken from the line is within the limits set by the National Electric Light Association, meeting the requirements of the power companies with regard to starting current. The efficiency and power factor is normal for squirrel-cage motors. These motors are available in sizes up to 50 hp.

General News Section

The Marlin-Rockwell Corporation, New York, manufacturers of ball bearings, has purchased the plant of the Strom Ball Bearing Manufacturing Company, Chicago.

The passenger station and freighthouse of the Denver and Salt Lake at Denver, Colo., was completely destroyed by fire of undetermined origin on August 22. The loss was estimated at $80,000.

The Western Electric Company, Chicago, has acquired a building at 570 Indiana street, Savannah, Ga., which will be remodeled and equipped for a factory branch and distributing works.

Miller-Stiles and the arc welder division of the U. S. Light & Heat Corporation, announces the removal of their New York office from the Grand Central Terminal Building to 161 W. 64th St., New York City.

The night air mail from New York to Chicago, which completed its first month on July 31, reports having carried 6,500 lb. of mail. Eastbound, the total was about 7,000 lb.; and all trips in both directions were made without serious mishap.

The Illinois Central expects to complete the electrification of its Chicago suburban service and have trains in operation under the new system six months ahead of the time, February 20, 1927, specified in the agreement between the railroad and the city.

A movement for the organization of Pullman porters is said to be under way in several localities, particularly in New York. The impetus seems to be coming from outside the service and to be working more or less under cover. Shorter hours, higher wages and pay for overtime and preparation will be demanded when the organization is well organized, it is said.

The engineman and fireman were killed and 14 passengers were injured in a head-on collision between the eastbound and westbound Panoramic specials of the Denver & Rio Grande Western in Granite Canyon, 10 miles west of Buena Vista, Colo., on August 20. It is reported that the cause of the collision was the failure of one train to receive orders to stop at Granite.

Georgia seems likely to be the next state to enact a law requiring automobiles to be brought to a stop before being driven across a railroad. The two houses of the legislature have passed bills designed to provide such a law. Both of the bills are characterized by rather crude provisions, but there is said to be a strong sentiment in favor of getting together and laying a completed law before the governor at an early date.

A reception to the neighbors would appear to be a proper name for the arrangements effected at the division terminal of the Louisville & Nashville at Etowah, Tenn., on August 3; about 600 people visiting the shops of the company at that place on the invitation of the officers of the road. This was adopted as one of the ways in which to take the public into their confidence. From 9 a. m. until 3 p. m. guides conducted parties of visitors through the shops every 30 minutes.

Ninety employees of the Pennsylvania Railroad System were retired from active duty on August 1, under the company's pension plan, and placed upon the "Roll of Honor." Seven of those have been in the employ of the road for 50 years or more each, while 55 have had records of 40 years' service or more. Since the establishment of the Pennsylvania's pension plan, on January 1, 1900, a total of 18,374 employees have been retired under its provisions; of whom 8,262 are still living.

The Illinois Central has contracted with the Union Switch & Signal Company for the materials for the installation of the Union continuous control automatic train stop system on the engine division between Fort Dodge, Ia., and Waterloo, 100 miles, single track, and the equipment of 38 locomotives. This division is the one included in the second order of the Interstate Commerce Commission, and the contract is in addition to that which the Union company has for an installation on the Champaign division, 123 miles, double track.

A total of 22,558 persons visited Glacier Park this season up to August 1 as compared with 16,282 in the same period of 1924. During July registrations aggregated 17,443, compared with 12,463 in July, 1924. Of the total for the season 9,837 were railroad tourists, while 12,721 used private transportation as compared with 5,136 and 11,146 respectively, for the previous year. During July railroad tourists amounted to 7,722 as compared with 3,977 in 1924 and those using private transportation totaled 9,721, compared with 8,486 for July of the previous year.

The Interstate Commerce Commission by an order dated July 21, has authorized the Illinois Central to install automatic train control on its road between Waterloo, Iowa, and Fort Dodge, 100 miles, instead of installing on a division between Chicago and Memphis as was called for by the Commission's order of January 14, 1924. This action was taken by the commission on condition that the order shall not result in extending the time within which the order shall be complied with, namely February 1, 1926. The road also must agree that the amendment does not entitle it to claim, in court or elsewhere, any extension of time beyond February 1, 1926.

New Haven to Give Receipts for Commutation Rate Increase

The increased fares for monthly and 50 ride tickets on the New York, New Haven & Hartford between New York City and points in New York State and Connecticut went into effect on August 1. C. A. Van Auken, cor-

poration counsel of New Rochelle, N. Y., speaking for New Rochelle and other cities and in behalf of complaining ticket holders, has continued his efforts before the Supreme Court of New York to secure an injunction forbidding the adoption of the advanced rates; and on August 4, although the question of the injunction had not been decided, he secured an order from Justice A. S. Tompkins requiring the railroad company to give, with each ticket, a certificate promising to make refund in case the action of the Public Service Commission or of the courts should finally hold the new rates excessive. To this condition the railroad company agreed; at the same time protesting that the court at this time has no jurisdiction in this proceeding.

Union Train Control on 84 Miles of the Pennsylvania

The Pennsylvania has contracted with the Union Switch & Signal Company to furnish material for the installation of the Union three-indication continuous automatic train stop system for its line between Baltimore, Md., and Harrisburg, Pa., 84 miles, double track. Alternating current polarized track circuits will be used throughout. Both the signal and train control energy will be 100 cycles, and will be fed from sub-stations at York, Lemoyne and Baltimore. A total of 162 locomotives will be equipped for operation over this division, and the train stop apparatus for these engines, together with the necessary position light signals and a.c. track circuit materials, will be supplied by the signal company.

Fall in Price of Coal Slows Up Swiss Electrification

The improvement of traffic and earnings on the Swiss Federal Railways in recent years brought about the general acceptance of the opinion that a period of steady recovery was definitely at hand and that the program for electrification was in the national interest from all points of view, according to Commercial Attaché Jones at Paris. Since the beginning of 1925, however, operations have not shown such favorable results, and it appears that the returns for 1924 may have reached a point which will not be equaled regularly.

As a consequence, it now appears questionable whether conclusions heretofore generally accepted are sound and whether the plans already adopted for railway development should not be materially modified. These points raise the questions as to whether the increase of the capital account necessary for carrying out the electrification program is justified, and whether the general electrification of the roads would be truly economic.

The capital account in 1924 already called for about 100,000,000 Swiss francs in service charges and 13,000,000 francs for amortization, or between 9,000,000 and 10,000,000 francs per month. With this heavy charge already undertaken and with the operation account showing less favorable returns during the first 4 months of 1925 than in the similar period in 1924, it is questionable whether it is wise to speed up the electrification program, which will in turn make greater the already heavy fixed charges.

Strength is given to the call for a revision of the electrification program by the fall in the cost of coal and the consequent reduction in the cost of operating steam equipmet. The average price paid for mineral fuel in 1923 and 1924 was 53.11 Swiss francs for coal and 64.43 Swiss francs for briquettes delivered at the Swiss border. This brings the average cost per locomotive fuel during these years to 56.88 francs, compared with 63.50 francs as the cost of electric power equal to that produced by a ton of coal. Coal prices have continued to fall in 1925 and now stand at about 49 francs, with probabilities of further decreases.

Under these circumstances, with already heavy fixed charges, decreasing traffic, and high freight and passenger rates, it is obvious that the demand for a revision of the electrification program, or at least a slowing down of its execution until the economic outlook becomes clearer, will receive increasing popular support.

Electrification of Austrian Railways

Preliminary plans for the electrification of the Austrian Federal Railway lines from Salsburg to Woergl and from Kufstein to Brenner are well under way, according to the published report of the electrification bureau of the railways, says Commerce Reports. These are the projects for which the League of Nations released a portion of the foreign credits a month ago, and several large orders have already been placed. The Austrian Siemens-Schuckert-Werke have received an order for the construction and equipment of the substation at Feldkirch, and the construction of transmission lines from Ruetzwerk has been awarded to the A. E. G. Union and the Oesterreichische Bergmann-Elektrizitaetsgesellschaft. This latter concern is also constructing the cable from Bludenz to Feldkirch.

Seven fast mountain passenger locomotives have already been shipped and are in operation between Innsbruck and Bludenz. In addition, 20 passenger locomotives have been ordered, of which 19 are already furnished; 12 of these are in use along the Attnang-Steinach line, and 5 on the line from Innsbruck to Bludenz. Furthermore, 20 freight locomotives have been furnished and are in operation, and 4 fast freight locomotives for use in the valley are under construction.

The total expenditure on this scheme during the second quarter of 1925 amounted to 8,525,000 schillings, of which 5,905,000 schillings were devoted to new constructions and the remaining 2,621,000 schillings to the purchase of rolling stock. (The schilling exchanges at 14.1 cents.)

The Kind of Radio the Railroads Need

I. C. Forshee, telegraph and telephone engineer of the Pennsylvania, in an address before the national convention of the Radio Relay League at Chicago, outlined the radio devices which, if developed, could be used in quantity by the railroads.

Pointing out the need of better communication between the engine and caboose of long freight trains, especially during storms or foggy weather, Mr. Forshee said there was an immediate demand for "a two way service that is reliable under all conditions, economical to install, maintain and operate, rugged to withstand the service conditions and relatively simple to operate."

"Small portable radio sets that could be used to bridge the gaps caused by storms or washouts and operate reliably over distances up to, say, five miles, would be considered favorably by railroad superintendents of telegraph," he added. "They would have to be rugged, economical, and also relatively simple to operate and maintain."

The installation of radio receiving sets on passenger trains has been experimented with on various railroads, Mr. Forshee said, but as a general thing they have not been retained as regular equipment.

"The apparatus available now would make it possible to furnish this service, if there were a real demand for it, in a more satisfactory manner than heretofore. The likes and dislikes of the traveling public are variable quantities and that also applies to radio entertainment," he said.

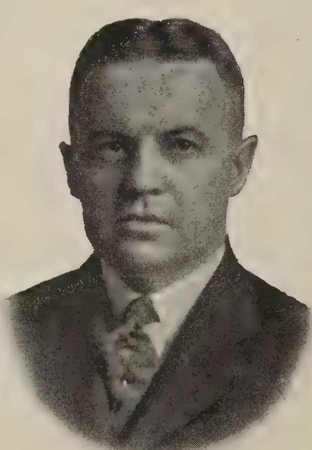
"There are certain conditions that exist on and along a railroad that are appreciably different than at home, such as axle generators and fan motors on the cars, headlight generators on the engines, power lines along the route with occasional defective insulators, tunnels in which the reception is practically dead, deep cuts, steel bridges and buildings that reduce the volume of reception in varying degrees, and the curvature of the track which affects the reception where the antenna has any directional effect.

"For these reasons, together with the cost to operate and maintain, the railroads, generally, have refrained from making this a part of their regular train equipment."

Mr. Forshee expressed the thanks of the railroads in general and the Pennsylvania System in particular for the assistance given by the league in transmitting messages in tests and under conditions when ordinary wire communications had been temporarily suspended on account of breaks. An arrangement for handling messages for the Pennsylvania through amateur operators of the league has been in effect along the Pennsylvania lines for about two years.

Personals

Harold Bates has recently joined the sales department of the Bridgeport Brass Company and will be engaged with matters pertaining particularly to sales organization and research. Mr. Bates has had considerable experience in sales and engineering work. After serving in various capacities in the public utility business, mainly with the Boston Elevated Railway, he assumed charge of new construction projects in Connecticut and Massachusetts for the electric traction interests then controlled by the New York, New Haven and Hartford Railroad Company. Later his work developed along the lines of a scientific study of railway operation for the Connecticut company.



Harold Bates

Leaving public utility for industrial fields, Mr. Bates aided in the development of the sales program of the Winchester Repeating Arms Co., during the crucial period immediately following the war. For five years Mr. Bates served successively as sales engineer in charge of the development of new products, superintendent of the sales engineering department, supervisor of sales planning and later in charge of special and jobbing sales of all new products. In his present position with the Bridgeport Brass Company he will work out plans to broaden the scope of the brass company's service to its customers.

V. R. Hasty has been appointed electrical engineer of the Union Pacific, with headquarters at Omaha, Neb., to succeed E. H. Hagensick, who has resigned.

E. H. Hagensick, electrical engineer of the Union Pacific for the past six years, has resigned to become associated with the Pyle-National Company, Chicago, and the Oliver Electric & Manufacturing Company, St. Louis, as sales engineer in the northwestern territory. Mr. Hagensick's headquarters are in the Builders' Exchange building, St. Paul, Minn.

Trade Publications

In the O. B. Bulletin for July and August, issued by the Ohio Brass Company, an interesting story will be found on the subject of material used in insulating compounds.

The Lincoln Electric Company, Cleveland, Ohio, has recently published a 24-page, illustrated booklet entitled "Lincoln Stable Arc Welder." Photographs of the various types of the Lincoln equipment are shown.

The Central Electric Company, Chicago, has recently issued a new 20 page catalogue on its Attalite commercial luminaires. New lines include a new Attalite security screwless holder, a clear type Attalite and the Renaissance type Attalite. The new booklet bears the number 96.

The General Electric Company, Schenectady, N. Y., has recently published a four-page bulletin illustrating and describing constant speed direct motors type C.D. The motors range from three to 200 horsepower and are for operation on circuits from 115 to 550 volts.

Electric Storage Battery Company, Philadelphia, Pa., in a 32-page illustrated catalogue explains the use of Exide batteries for railway service. The batteries described are divided into three classifications: first, in sealed glass jars; second, in sealed rubber jars; third, in open glass jars.

Automatic Railway Substations is the title of a 31-page illustrated booklet recently issued by the General Electric Company. Many photographs show the interiors and exteriors of various types of substation buildings and numerous line drawings show the arrangement of the apparatus.

The Norma-Hoffman Bearing Corporation, Stamford, Conn., has recently issued two 20-page illustrated booklets. One of these is entitled "Norma Precision Ball Bearings" and illustrates and describes the Norma open and closed type of ball bearings. The second portrays the various types of the Hoffman Precision Roller Bearings.

Bridgeport Brass Company, Bridgeport, Conn., has recently issued a 16-page illustrated booklet containing technical data and tables on the subject of "Phono-Electric" trolley wire. Photographs show the installation of "Phono-Electric" wire on various railway lines throughout the United States. A new product, "Phono Hi-Strength," is also described.

Railway Electrical Engineer

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The Manufacturers' Section

A new department is included in this issue of the *Railway Electrical Engineer.* In past years the annual October issue has dealt with the A. R. E. E. convention only by publishing the reports presented. In view of the important part played by the manufacturers, a directory of exhibitors and a New Devices Section have been included this year.

The directory lists the names of all exhibitors at the convention with the products shown by each and the names of the men representing the company.

The New Devices Section is much larger than that usually included in the regular monthly issue and is the result of inquiries sent out to all manufacturers of electrical equipment who have products particularly suitable for railroad service. In each case in which an exhibitor at the convention is showing a new product, this fact is mentioned in the exhibitors directory and reference is made to a description of the product in the New Devices Section. Aside from aiding those at the convention, it is hoped that this section will bring the convention nearer to those who are unable to attend.

Sixteenth Annual Convention

The sixteenth annual convention of the Association of Railway Electrical Engineers is about to meet in Chicago at the Hotel Sherman. The meetings will be held each day from October 27 to 30, inclusive, and the exhibits of the Railway Electrical Supply Manufacturers' Association will be on display in an adjacent room from 6 o'clock on Monday evening, October 26, until Friday noon, October 30.

This issue of the *Railway Electrical Engineer* contains all of the committee reports that will be presented during the convention with the possible exception of a verbal report to be presented by the committee on self-propelled vehicles.

The significant features of this year's convention are the brevity of most of the reports and the comparatively small number of committees reporting. The total length of the reports is approximately one-third of that of last year. This is largely due to the fact that the report of the committee on illumination is not of as great length as last year.

It is perhaps not a bad idea to limit the number of committees reporting, since there never seems to be enough time to give the reports full and complete discussion. Discussion on many reports has frequently been curtailed for the want of time. That the electrical engineer has a large number of subjects under his direction is generally conceded. With committees covering each one of these subjects at each meeting, the volume of reports and discussions is so great as to be unwieldy. It is to be hoped that with the shorter program this year, full and adequate discussion will be possible.

The convention exhibits promise to be of great interest and certainly their proximity to the meeting room will be a decided advantage which was noticeably lacking at the convention a year ago. Both the meetings and the exhibits are of importance and if the convention is to be successful each must come in for its share of attention. With a shorter program as outlined and more time for discussion there is reason to believe that the reports presented will receive full consideration, and that ample opportunity will be afforded for careful and deliberate inspection of the devices in the exhibit hall.

Air Mail and Other Innovations

Means of speedy communication are vital to the business world, and the recent installation of air mail service may quite possibly prove to be the most useful and important measure of postal improvement since the adoption of the railway postal car system in the sixties.

Transmission of mails via air routes is effected in less than one-half the time required by train. Night air mail letters dispatched from New York in the evening are delivered at their address in Chicago by first carrier delivery the following morning; or if forwarded from Chicago by train to other points, will move by the first morning train instead of by a late evening train. The delivery of such letters in postal territory served from Chicago will thus be expedited by at least twelve hours and often much more.

A similar gain in time is made with respect to other air mail stations where mails are transferred to railroads for distribution in adjacent territory. Thus, in a very wide zone on either side of the transcontinental air mail route, letters destined to any point within that zone may be expedited in delivery by several hours.

In many business transactions time is a factor of great importance. The air mail service is of special value in all such cases. It supplies a desirable facility, especially beneficial to business men. There has been some criticism of the night air mail service, but if it succeeds, it will mark another epoch in the field of transportation. Like

all the forms of transportation, its success is based on the service rendered.

The air service is only one of several recent innovations in the transportation field. Buses and trucks, because they offer more convenient and often cheaper service, took an appreciable amount of business from the railroads. To improve branch line and short haul service, various types of self-propelled cars have displaced steam trains and now a few roads are operating buses and trucks on the highways. Much more than ever before is being demanded of locomotives with the result that several new types are being tried. Among these the Diesel-electric holds great promise. It should be significant to the electrical man that most of these improved forms of motive power are dependent in their operation on electrical apparatus. The use of heavy electric traction continues to increase at a uniform, if rather slow rate, but in the meantime, electricity is rapidly becoming indispensable in practically all other branches of railroad work. Electrical machinery renders a form of service that is usually impossible by other means.

Illumination Report

The subject of illumination as it pertains to the many and widely varying requirements of railroad operation is most strikingly brought out by the report of the committee on illumination presented at the sixteenth annual convention of the Association of Railway Electrical Engineers. Year after year, illuminating intensities have been increased and types of lighting and fixtures have been improved until standards have been reached, at least in some phases of illumination which appear to be difficult to excel.

The report of the committee, which appears on page 296, includes two sections of a manual on illumination which will be issued by the Association of Railway Electrical Engineers in the near future. This report, together with the sections of the manual, constitutes by far the most extensive report to be presented at the convention. It represents careful and exhaustive study on the part of the committee, augmented by the experience of numerous illuminating experts. One has but to examine the photographs which accompany the report to appreciate the truly remarkable progress which has taken place in the illuminating art in recent years. All "cut-and-try" methods formerly in vogue, have been completely discarded. The guess-work, once so common in lighting installations, has given place to accurate scientific illuminating data which makes it possible to determine exactly what results will be obtained before any of the lighting units have been installed.

There are two sections of the manual still to be completed—one on car lighting and another on yard lighting. The former may practically be considered as standardized, but there is still much to be learned regarding the latter in spite of the fact that numerous installations have been made. Both of these sections will be published in a subsequent issue of the *Railway Electrical Engineer.*

The committee has spared no pains to make the manual a useful and workable tool and is to be congratulated for presenting so valuable a contribution to the members of the association.

Electric Traction and Wired Wireless

Electric locomotives were placed in operation on the Virginian Railway on September 21. The inauguration of this service is important for two reasons. The first of these is the kind of work done by the locomotives. A train of 6,000 net tons is now taken up a 2.07 per cent grade, 15 miles long, at 14 miles an hour by two locomotives. Each locomotive is normally rated at 7,125 hp. and during accelerations a total of 20,000 hp. is applied to the train. The nearest approach to this kind of performance that has ever been reached before is the steam service on the Virginian which was replaced by the electric. In this service three Mallet locomotives moved trains weighing from 5,500 to 5,700 tons up the same grade at about 7 miles an hour. The new service is, therefore, the most notable example in existence of what can be accomplished with unusually heavy freight trains by using electric motive power.

The second point of particular interest in connection with this electrification is the results of experiments made with wired wireless communication. Apparatus has been installed on two of the electric locomotives and signals between the road engine and the pusher are used to facilitate the handling of the train. Although the apparatus is still in an experimental state, it is used successfully and it would appear that the application is not limited to electric locomotives. Signals have been sent back and forth between two locomotives, not in the same train, at a distance of six miles and the possibilities of such a device are, therefore, something which, with the imagination of the electrical engineer, may be developed into a wide field of application.

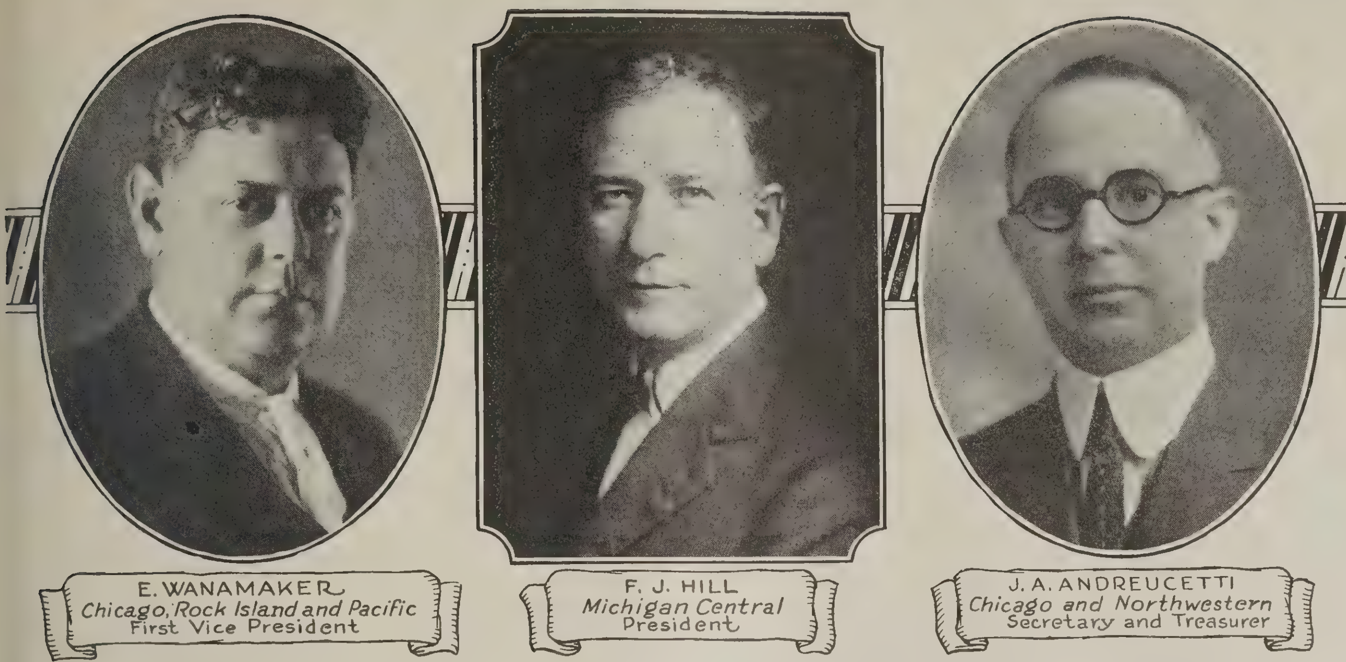
New Books

Transmission Line Formula—By Herbert Bristol Dwight, 216 pages, 5¾ in. by 8¾ in., illustrations and diagrams, bound in cloth. Published by D. Van Nostrand Company, New York. Price $3.00.

The book abounds in useful information for engineers engaged in laying out transmission lines for specific purposes. Its pages are full of diagrams, charts and particular problems are worked out and illustrated to show the methods used in securing results. All of the properties and phenomena which are adherent in transmission lines are dealt with in such a manner as to show how and to what extent the undesirable features of reactance, skin effect and line drop can be overcome. Single, two and three phase line construction are covered and cables of various types as well as solid conductors are treated at length. In the latter part of the book, there are numerous tables giving the properties of copper, aluminum wire and cables.

Electrical Precipitation—By Sir Oliver Lodge, Lond., Oxford University Press; Humphrey Milford, 1925. (Institute of Physics. Physics in Industry, v. 3.) 40 pp., plates, tables, 10 x 6 in., boards. $1.00.

The lecture deals with the natural precipitation of atmospheric moisture as rain or mist and with the artificial precipitation of dust and fumes by electrical methods. The author then proceeds to contemplate the possible modification, in the future, of atmospheric and meteorological phenomena by combining natural and artificial precipitation. An appendix gives some notes on commercial installations of precipitating apparatus.



Officers of the Association of Railway Electrical Engineers

Association of Railway Electrical Engineers Sixteenth Annual Convention

October 27th to 30th, Chicago

Convention Program

Meetings in the Grand Ball Room, Mezzanine Floor, Hotel Sherman,
Exhibits Will Be Located in Exhibit Hall, Mezzanine Floor

TUESDAY, OCTOBER 27TH

Session 10:00 A.M. to 12:00 Noon

Address of President
Report of Secretary-Treasurer
Report of Auditing Committee
Unfinished Business
New Business
Election of Officers

WEDNESDAY, OCTOBER 28TH

Session 9:30 A.M. to 12:00 Noon

Committee on Train Lighting (page 311)
Sponsor Committee on Wires and Cables (of "American Engineering Standards Committee") (page 305)
Committee on Power Plants (Progress Report) (page 307)

THURSDAY, OCTOBER 29TH

Session 9:30 A.M. to 12:00 Noon

Committee on Safe Installation and Maintenance of Equipment (page 308)
Committee on Illumination (page 296)
Committee on Self Propelled Vehicles (Progress Report)

FRIDAY, OCTOBER 30TH

Session 9:30 A.M. to 12:00 Noon

Committee on Train Control (page 306)
Committee on Locomotive Electric Lighting (page 310)
Committee on Loose-Leaf Manual (page 306)

Registration

Please register and secure badges and tickets at the Secretary's desk. Located near entrance of Exhibit Hall on Mezzanine Floor.

Theater, Dinner and Card Party tickets should be reserved at time of registering.

Entertainment

Exhibits are located in the Exhibit Hall on the Mezzanine Floor and will be open from Monday evening until Friday afternoon.

Wednesday afternoon, October 28, 2:00 P. M.—Theater Party for Ladies only: "The Student Prince," Great Northern Theater, 58 West Jackson Blvd. Secure tickets at Secretary's desk from Tuesday noon up to Wednesday noon. Tickets should be reserved at time of registering.

Wednesday evening, October 28.—Carnival Dance, Grand Ball Room, Mezzanine Floor, 8:30 P. M. Admission by badges.

Thursday afternoon, October 29.—Ladies' Card Party, "500" and Bridge. Crystal Room, first floor, 2:30 P. M. Admission by ticket. Secure tickets at Secretary's desk.

Thursday evening, October 29.—Informal Dance, Louis XVI Room, first floor, 8:30 P. M. Refreshments will be served. Admission by badges.

Friday evening, October 30.—"Sixteenth" Annual Dinner Dance and Entertainment, Grand Ball Room, Mezzanine Floor, 6:30 P. M. Secure tickets at Secretary's desk beginning Wednesday afternoon.

Report of Committee on Illumination

Office and Drafting Room, Passenger and Freight Stations, Storehouse, Warehouse and Pier Lighting Comprise the New Sections for the Manual

Committee:—

L. S. Billau, Chairman, assistant electrical engineer, Baltimore and Ohio; L. D. Moore electrical engineer, Missouri Pacific; G. I. Caley, electric and signal engineer, New York, Ontario & Western; G. T. Johnson, assistant engineer, New York, New Haven & Hartford; J. L. Minick, assistant engineer, Pennsylvania System.

To the Members:

Your Committee on Illumination submits following report on subjects that have been assigned to it:—

Incandescent Lamps for Train Lighting Service

During the past year there have been no important changes in the train lighting lamp schedule, those that have taken place being shown in Table No. 1. With the five sizes of type C lamps, namely, 15, 25, 50, 75 and 100 watt, 30-34 volt range, that the Association has adopted as recommended practice for meeting general requirements of train lighting it will be noted there has been a percentage increase in the use of all of them, and as to be expected a decrease in the use of the vacuum or B lamps. While there is still a greater demand for the 15 watt, G-18½ bulb lamp than any other size or type this is accounted for by its being standard for sleeping car berth light service. As the 15 watt, PS-16 bulb C lamp in the 30-34 volt range is superior to the B lamps of this size in mean lumen output throughout life, it is recommended that it be used wherever possible in place of the B lamps which will automatically bring about a reduction in price as the demand increases. In the 25 watt size the change from the use of the B lamp to the C lamp is taking place rapidly with the probability that by next year the 25 watt B lamp in the 30-34 volt range can be dropped from the lamp manufacturers' standard train lighting lamp schedule.

Last year your committee called attention to the fact that train lighting lamps were being manufactured in eleven different voltages. An analysis of the demand for the past year is given in Table 2, in which it is found that of the seven voltages for which there was more than a negligible demand that in the 30-34 volt range the standard 32 volt lamp amounted to 73.12 per cent and in the 60-65 volt range the standard 64 volt lamp, 56.77 per cent, of the total production for each of these ranges. As the elimination of odd types and voltages of lamps in the train lighting schedule is a part of the lamp manufacturers' general lamp simplification program, one of the important factors that will control future reductions in lamp costs, your committee recommends that serious consideration be given to the adoption of the standard voltage train lighting lamps by those who are not now using them.

Incandescent Lamps for Locomotive Service

The important development during the past year in lamps for locomotive lighting service has been the substitution of the P-25 bulb for the G-25 bulb in the 100 watt and other sizes of headlight lamps that have heretofore been manufactured in the G-25 bulb. This has not changed the light center length of the lamp or other essential features of its construction.

There has been some demand for the 250 watt headlight lamp in the same size bulb (P-25 or G-25) as the 100 watt headlight lamp. Your committee does not consider it a wise policy that lamps for two such important purposes as road locomotive headlight and switching locomotive headlight service should be furnished in the same type of bulb and consequently so little from point of view of appearance to differentiate them. If the manufacturers can produce a satisfactory 250 watt headlight lamp in the P-25 bulb, the committee sees no objection to its ultimately becoming standard for this service but feels that if this is done it will first be necessary to provide a different type or size of bulb for the headlight lamp for switching locomotive service.

There is still lacking sufficient service data relative to the per-

TABLE NO. 1

COMPARISON OF TRAIN LIGHTING LAMPS—1924 and 1925

Size in Watts	Size of Bulb	Vacuum (B) Gas Filled (C)	Rated Initial Lumens 1924	Rated Initial Lumens 1925	Approx. Mean Lumens Throughout Life 1924	Approx. Mean Lumens Throughout Life 1925	Approximate No. of Lamps 1924	Approximate No. of Lamps 1925	Annual Demand Percent Total 1924	Annual Demand Percent Total 1925	Percent Change
			30-34 Volt Range								
15	S-17	B	153	155	133	135	360,000	209,000	15.2	11.25	26.0—
15	G-18½	B	141	141	123	123	560,000	411,000	23.6	22.07	6.5—
15	PS-16	C	151	151	142	142	73,000	74,000	3.1	4.00	29.0+
25	S-17	B	273	273	219	219	55,000	82,000	10.7	4.42	58.7—
25	G-18½	B	243	243	207	207	220,000	118,000	9.3	6.34	31.8—
25	PS-16	C	310	300	285	285	165,000	284,000	7.0	15.27	118.0+
50	PS-20	C	740	705	700	670	315,000	252,000	13.2	13.53	2.5+
75	PS-22	C	1,215	1,215	1,150	1,150	30,000	26,000	1.3	1.42	9.1+
100	PS-25	C	1,700	1,690	1,610	1,610	15,000	12,000	0.6	0.66	10.0+
Total							1,993,000	1,468,000	84.0	78.96	
			60-65 Volt Range								
15	S-17	B	144	144	125	125	60,000	34,000	2.5	1.80	28.0—
15	G-18½	B	129	129	112	112	155,000	130,000	6.5	6.99	7.5+
25	S-17	B	255	255	204	204	50,000	82,000	2.1	4.43	111.0+
25	G-18½	B	235	235	200	200	40,000	28,000	1.7	1.50	31.7—
25	PS-16	C	...	267	...	253	......	24,000	..	1.30	...
50	PS-20	C	565	600	515	545	55,000	78,000	2.3	4.18	81.5+
75	PS-22	C	1,005	1,013	905	913	15,000	10,000	0.6	0.55	8.2—
100	PS-25	C	1,430	1,480	1,260	1,305	8,000	5,000	0.3	.029	3.2—
Total							383,000	391,000	16.0	21.04	
Grand Total							2,376,000	1,859,000	100.0	100.00	

formance of the 15 watt, S-17 and S-14 bulb cab lamps to justify the committee recommending at this time the adoption of the latter bulb as standard for cab light service. It is urged that the railroads continue to use the S-14 bulb lamp on an increasingly greater scale, advising the committee during the coming year of the performance secured as compared to the present S-17 bulb lamp.

New Incandescent Lamps for General Service

Recently the mazda lamp manufacturers have placed on the market the first of a simplified line of lamps, the 25 watt A-19 bulb mazda lamp in the 110-120 volt range. There are now about forty-five types and sizes of lamps 100 watts and under in use for general lighting for which it is proposed to substitute a new standard line consisting of five or six lamps of which the new 25 watt is the first to be produced.

The appearance of the new lamp is very pleasing, being somewhat similar to the P-19 bulb; it is all frosted, the frosting, however, being on the inside of the bulb making it easy to clean. This new method of frosting results in high transmission of light being much more efficient in this respect than the present method of frosting. All these new lamps will be made with coil filaments.

TABLE NO. 2
DISTRIBUTION OF TRAIN LIGHTING LAMP DEMAND BY VOLTAGE

Voltage	No. of Lamps in Voltage Group Demand	Per Cent of Total Demand
30-34 Volt Range		
30	2.92	2.30
32	73.12	57.75
33	11.85	9.35
34	12.11	9.56
Total	100.00	78.96
60-65 Volt Range		
60	10.21	2.15
64	56.77	11.94
65	33.02	6.95
Total	100.00	21.04
Grand Total		100.00

The lamp manufacturers plan to extend to the train lighting schedules, the same advantages of new bulb design, inside frost, reduced number of types, etc., which have been given to the new standard line in 115 volts. Your committee expects to take up this subject during the coming year.

Manual of Lighting Practice for Railroads

The principal work of the committee has been the completion of what might be termed the first edition of the "Manual of Lighting Practice for Railroads," as to be of value a work of this character will require revision from time to time to keep abreast with the progress of the art. The purpose and scope of the proposed manual were presented in the committee's report last year. In the form in which issued the following subjects have been covered:

Section 1—Fundamentals of Illumination and General Design Data.
Section 2—Railway Shop and Roundhouse Lighting.
Section 3—Office and Drafting Room Lighting.
Section 4—Passenger and Freight Station Lighting.
Section 5—Storehouse, Warehouse and Pier Lighting.
Section 6—Yard Lighting.
Section 7—Car Lighting.

Sections 1 and 2 were presented last year and while some changes and additions have been made, it was decided because of the space required not to re-publish them until they appear in final form in the Manual of the Association.

While the Lighting Manual has been confined almost entirely to the illumination engineering side of the subject an exception has been made in the case of mail car lighting. In view of the very complete detailed specifications for the lighting of mail cars as covered in the latest revision of the U. S. Post Office Department mail car specifications it was felt advisable to treat this subject in its entirety. As a consequence complete lighting and wiring layouts have been given including arrangement of circuits, etc., for the standard postal and mail apartment cars conforming to the Post Office Department specifications. It is proposed to include these specifications in the Association's Manual for convenient reference.

Your committee wishes to take this opportunity to acknowledge the able and extensive assistance it has received from the illuminating engineering staffs of the Edison and National Lamp Works of the General Electric Company and the Westinghouse Lamp Company, as well as the engineering data that has been furnished by other companies. It has been possible only through the collaboration of a number of engineers who specialize in the illuminating engineering field to present a work of this character.

Recommendations

Your committee recommends the following:

1st—That the 15 watt, S-17 bulb train lighting lamp be dropped from the list of train lighting lamps adopted by the Association to meet general requirements of train lighting service, as given in Table No. 3 in the 1924 report, and that this table as revised be placed in the Manual of the Association in the train lighting section.

2nd—That the complete "Manual of Lighting Practice for Railroads" with such revisions as the committee may deem advisable, be placed in the Manual of the Association.

3rd—That the committee as part of its work for the coming year give special consideration to what changes, if any, will be desirable in the train lighting lamps in connection with the lamp manufacturers' development of their simplified line of lamps, conferring with the Train Lighting Committee on this matter.

4th—That the committee in conjunction with the Committee on Locomotive Lighting endeavor to reach a decision during the coming year relative to types and sizes of bulbs for lamps for locomotive lighting service.

5th—That the study of the subject of flood lighting as applying to the railroad field be continued with a view toward establishing a more nearly standardized engineering practice covering its applications, as rapidly as the development of the art will permit.

Respectfully submitted,
COMMITTEE ON ILLUMINATION.

APPENDIX A—MANUAL OF LIGHTING PRACTICE FOR RAILROADS

SECTION 3—The Lighting of Offices & Drafting Rooms

300—General Requirements

From the standpoint of utility, the problem of office lighting can be very simply stated. Briefly, it is to provide the best illumination for sustained vision of flat surfaces in horizontal or slightly oblique planes in which papers, books, photographs, etc., are usually examined. Experience has shown that in offices and drafting rooms, perhaps more than in any other locations, an ample intensity of soft, well diffused light must be provided in order that discomfort may be avoided and that the eyes may not become excessively fatigued by close application for long periods of time. The perception of objects in their three dimensions, so important in the industries and in the arts, is here relatively unimportant; and shadows, therefore, should be subdued, if not entirely avoided. In order that glare may be reduced as much as possible there should be no extreme contrasts in the brightness of objects within the field of view. The lighting system should be designed to permit flexibility in the arrangement of office furniture, and it should be easy of maintenance and satisfactory in appearance.

301—Method of Lighting

When all factors are considered, there is no question as to the superiority of a proper system of general illumination over a system of local lighting for offices and drafting rooms. The latter is objectionable from several standpoints; there is a great liability of glaring reflections from desk surfaces and glazed paper; employees lose time shifting the light about, breakage of lamps is increased, and there is often a marked contrast between the brightly lighted desk area and the rest of the room. These objectionable features of local lighting can be eliminated with a well designed system of general illumination.

302—Levels of Illumination

As outlined in Section 1 the first step in designing a particular lighting system is to decide on the level of illumination to be provided. Attention is here called to the fact that, while intensities of 10-12 foot candles for general office work and 15-20 foot candles

for drafting rooms are considered good practice at the present time, intensities of 50 foot candles from properly diffused sources are thoroughly practical. The standards of illumination are rapidly and continuously rising along with the keener appreciation of the value of artificial lighting. For this reason, and also to take care of future changes in the lighting requirements in certain areas, it is always advisable to provide wiring and equipment which will at least accommodate the next larger size lamp than would be used to meet present requirements. Furthermore, allowance should be made for the fact that even in a small group of persons, one or more with defective eyesight will usually be found, and the lower limits of permissible intensity should not be approached so closely that unnecessary hardship is imposed on anyone. The chart in Fig. 302 shows the results of tests which have been conducted to determine the relations between the time required for discrimination of details and the amounts of illumination supplied, as measured in foot candles. The curves show that the eye discriminates more rapidly under high levels of illumination and also that in increase in illumination benefits the astigmatic eye to a relatively greater extent than the normal eye; or conversely, at the lower levels of illumination, the astigmatic eye is handicapped even more than the normal eye.

303—Choice of Units

One of the most important factors in office lighting design is the choice of luminaires. Soft, well diffused light is recognized as essential to good office illumination, and for this reason direct lighting units of the open reflector type are giving way to indirect lighting units, semi-indirect units employing bowls of heavy density glass and in some cases, direct lighting units of the enclosing type. Extreme contrasts, such as exist between the brilliant filament of a lamp in an open reflector or enclosing globe and the average wall brightness of a room are capable of producing marked discomfort and glare. In offices where the position of the eye with respect to the light source must remain practically without change for considerable periods of time, fatigue rather than instant discomfort becomes the determining factor, and therefore such contrasts should be limited to the lowest practical minimum. This means that for best results the choice of units for offices is practically limited to totally indirect and dense glass semi-indirect luminaires. The highly diffused light from the totally indirect type is especially desirable in drafting rooms where any shadow is very annoying. With indirect or semi-indirect lighting systems it is very essential that the ceiling be light in color and so maintained in order to secure a maximum efficiency of reflection. Side walls of considerable area, however, should not be finished so near to white that they will reflect a large volume of light into the eye nor should they be so dark as to cause undue contrast and needless absorption of light. Where semi or totally indirect units cannot be used because of exceptionally bad maintenance conditions or where the ceiling is dark in color or badly cut up by means of similar obstructions, one piece enclosing units may be used but care should be taken to see that they are provided with globes of good diffusing quality and of such sizes as to result in low brightness.

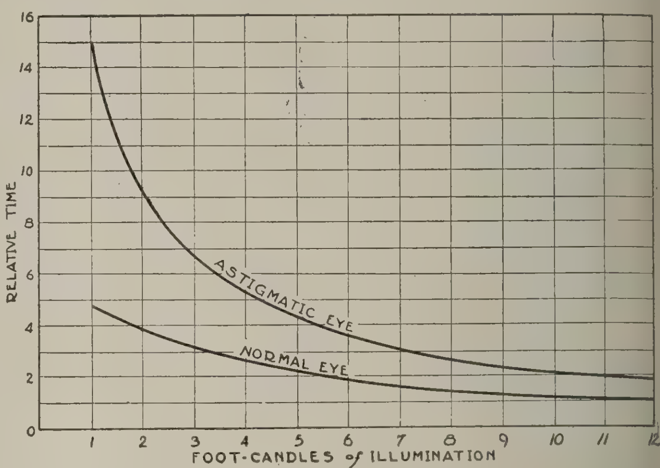


Fig. 302—Higher Illumination Decreases the Time Required for Vision and Lessens the Handicap of Astigmatism

Fig. 301—Drafting Rooms Illuminated by 300 Watt Clear Mazda C Lamps Located in Totally Indirect Luminaires Spaced on 10 Ft. x 10 Ft. Centers

An additional advantage possessed by light sources of a low order of brilliancy is that their reflections in polished surfaces are less harsh and annoying. In many cases desks are thoughtlessly given a high polish—not infrequently they are covered with plate glass—and in such cases the reflection of a source may approach in brilliancy that of the source itself. It is difficult to avoid reflections entirely but their harmful effects can be minimized by employing only units of low brilliancy, and by arranging them carefully with respect to the position of the desks, or vice versa.

The general discussion given in Section 1, Par. 113, on shadows applies particularly to the subject of office lighting. As a rule, the minimum shadow results with totally indirect units, since they distribute the light over a large portion of the ceiling whence it is diffused throughout the room; the maximum of shadow which does not prove objectionable in office lighting results with direct lighting, semi-enclosing units of large size. In the opinion of many authorities, semi-indirect or luminous bowl indirect units which provide in addition to the light they send to the ceiling, the direct light of the bowl to destroy the effect of flatness, are the most satisfactory for office lighting.

In Fig. 303 are shown typical office lighting equipments. These include semi-indirect, totally indirect and enclosing luminaires. Of the semi-indirect units the closed top type is rapidly gaining favor over the open type and their use is strongly recommended because of a somewhat slower depreciation and comparatively easier maintenance.

Fig. 303—Modern Office Lighting Equipment

304—Location and Number of Lighting Units

The location and number of outlets are affected by considerations of the constructional features of the office, uniformity in lighting, and the avoidance of glare. This subject has already been discussed in Section 1 and little more need be said here except to call attention to the desirability of keeping well within the spacing limits in order to avoid any possibility of objectionable shadows. It is not infrequently the case, even in small offices, that beams divide a ceiling into a number of rectangular bays, and here especially a symmetrical arrangement of units is desirable from the standpoint of appearance.

In planning office lighting a little consideration of future needs will often indicate the advisability of locating the units in such a way that if old partitions must be removed or new ones built in, the outlets already installed will still be usable. This factor alone is frequently of sufficient importance to justify the use of a greater number of outlets than would be necessary to meet the existing lighting requirements. Special structural features such as the placement of doors and windows should receive attention. Fig. 305 illustrates how the use of 8 units in a room where 6 would satisfy conditions of uniformity permits the change from a general to two private offices. This arrangement also shows how the locating of outlets in line with the windows will eliminate any chance of their interfering with future partitions. It is an advantage in an office building if the number of different sizes of units and lamps employed can be kept small in order to facilitate replacement from stock. Sometimes it may be desirable to wire for locations where it is thought units may at some future time be needed and to seal the wires beneath the plaster or cap the outlets until required.

305—Illumination Design for an Office

The floor plan of a typical general office space to be lighted is 18 ft. x 34 ft. as shown in Fig. 305.

The ceiling, which is 11½ ft. high, is a flat white (very light) in color. The sidewalls, though fairly light in color would be classed "fairly dark" due to a large percentage of this area being windows and doors which have low reflecting value.

Following the steps outlined in Section 1—

1. *Foot Candle Illumination.*

From Table 1, 10 foot candles are recommended for general offices.

2. *Type of Lighting Units.*

Consulting the guide to the selection of lighting equipment, Table 2, it may be seen that luminaires No. 23-28 inclusive have the best ratings for those factors outlined earlier in this chapter. Unit No. 25 is selected.

3. *Location of Outlets, Mounting Height, and Number of Units.*

The average desk height, hence the working plane, is 2½ ft. above the floor. With a semi-indirect luminaire, the ceiling acts as the source of light. Therefore, the height of light source above the working plane is 11½ ft.—2½ or 9 ft. Referring then to Table 3b, Section 1, it is found that the greatest permissible spacing between outlets is 13½ ft. Likewise, from this same table the distance from the sidewalls to the first row of outlets should not exceed 4½ ft. since in a general office desks are usually located along the sidewalls. Finally, this table shows that the suspension distance from the ceiling to the top of the reflector should be at least 2¼ ft.

As shown in Fig. 305 these limits would permit a system employing 6 outlets spaced on 10 ft. x 13 ft. centers. Noting the window locations and with a thought of providing flexibility in partition arrangement, it seems desirable to provide 8 outlets located on 9 ft. x 10 ft. centers.

4. *Lamp Size.*

In Table 4 it is found that a room 18 ft. x 34 ft. with the ceiling height (semi-indirect lighting) 9 ft. above the working plane has a room index of 2.

It will be seen from Table 5 then that the coefficient of utilization of .34 is obtained for luminaire No. 25 when installed in a

room with an index of 2.0 and with very light ceilings and fairly dark sidewalls.

Solving equations A, B and C.

A. Area in Square Feet per Outlet
$$= \frac{\text{Total Floor Area in Square Feet}}{\text{No. of Outlets}} = \frac{18 \times 34}{8} = 76.4$$

B. Lamp Lumens Required Per Square Foot
$$= \frac{\text{Foot Candles} \times \text{Depreciation Factor}}{\text{Coefficient of Utilization}} = \frac{10 \times 1.3}{.34} = 38.3$$

C. Lamp Lumens Required Per Outlet ...... = Area in Square Feet Per Outlet (From A) × Lamp Lumens Required Per Square Ft. (From B) = 76.4 x 38.3 = 2920

The size of lamp to be used can now be found by means of Table 6 which gives the lumen output of mazda lamps. It shows that a 200 watt mazda C lamp has an output of 3240 lumens, quite close to the required value. This lamp would here provide

$$\frac{10 \times 3240}{2920} = 11.09 \text{ foot candles}$$

SECTION 4—Passenger and Freight Stations
PASSENGER STATIONS

400—General

Illumination in and around passenger stations is provided primarily in order to add to the safety and convenience of the public and employees. Any lighting equipment which does not directly contribute to this security and convenience should be avoided.

401—Waiting Rooms

The principal requirement for lighting the waiting room is that of providing adequate illumination to create a cheerful yet comfortable atmosphere throughout and to permit reading with ease for short periods of time.

In a discussion of the proper lighting it is well to divide these interiors in two groups: first, the modern terminal waiting room and second, the waiting room of the way stations found in the medium sized cities and towns between terminals.

In Fig. 401 is shown a modern terminal waiting room, the lighting of which consists of two batteries of floodlights installed in balconies at the two ends of the room which illuminate the ceiling and clerestory walls. The lower portion of the walls, the columns and cornices of the belt course are effectively lighted by torcheres or floor standards. From the photograph it may be seen that this rather elaborate lighting scheme is quite in keeping with the ornateness of the building.

It is evident, however, that no set rules may be made for interiors of this type; all possible forms of lighting having been employed with varying degrees of success. Each one requires individual treatment in order that the lighting may not only be in harmony with other architectural features but also designed from an engineering standpoint as well. For this reason, it is strongly recommended that a competent illuminating engineer be called in to assist in planning these more elaborate systems.

The medium and smaller sized stations do not present as great a problem as the terminal and here a more standardized treatment is possible. The enclosing type of luminaire is becoming more and more popular for these interiors due to their utilitarian value and particularly good maintenance.

In Fig. 402a is shown a suggested layout of outlets for a waiting room 60 feet long and 40 feet wide. As indicated six outlets are employed, each equipped with 1-500 watt clear mazda C lamp placed in a totally enclosing luminaire with units mounted 15 feet above the floor. In Fig. 402b is shown a somewhat smaller room (dimensions 40 ft. x 25 ft.) employing five outlets. Each outlet is equipped with 1-300 watt clear mazda C lamp located in an enclosing luminaire with the outlet located approximately 15 feet above the floor.

Fig. 304—Small Office Illuminated by 300 Watt Clear Mazda C Lamps Located in Closed Top Dense Semi-Indirect Luminaires Located on 10 Ft. x 10 Ft. Centers

In every case the number of outlets to be used may be determined by applying the spacing-mounting height tables given in Section 1. In the smaller type stations it is desirable to provide

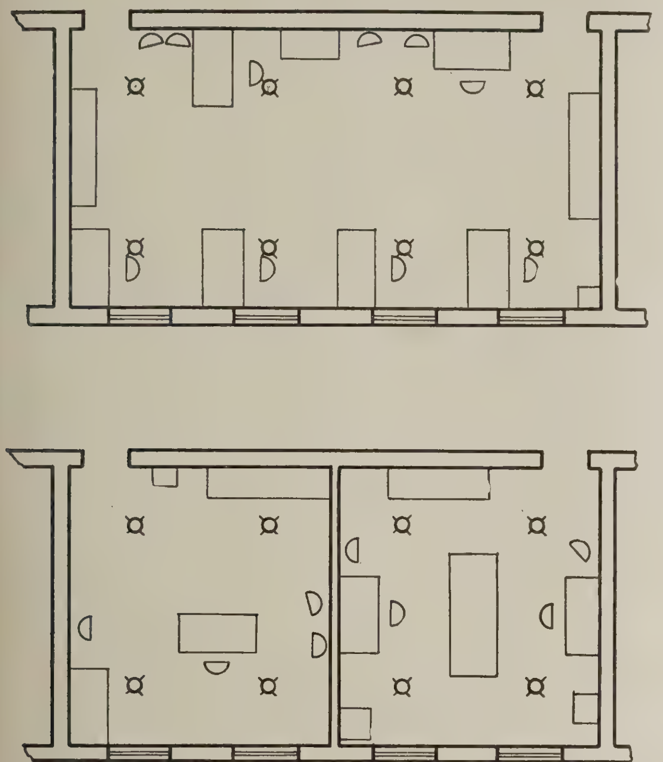


Fig. 305—In Offices Outlets Should Be Located So As to Provide for Any Ordinary Arrangement of Partitions

means whereby this illumination may be reduced during the late hour intervals when traffic is light. This may be accomplished in Fig. 402a by arranging any two outlets on a separate circuit while in Fig. 402b the central unit may be separately controlled. Local conditions will govern the most desirable wiring arrangement.

The use of a few high wattage lamps is preferable to the older method of employing a cluster of low wattage lamps since advantage is taken of the higher efficiency of the larger lamps as well as their reduced overall operating costs.

402—Ticket Offices

Enclosing or semi-indirect luminaires providing general illumination in the order of 6 foot candles should be installed in the ticket office. At the ticket window it is desirable to provide additional local lighting to facilitate speed and accuracy. Suitable equipments for this purpose are shown in Fig. 403.

403—Toilet Rooms

Enclosing luminaires equipped so as to provide an illumination of 4 foot candles are recommended in toilet and washrooms. In view of the fact that it is generally admitted that light is invaluable as a sanitary precaution particular attention should be given to the arrangement of outlets to see that the spacing limits in these locations are strictly adhered to thereby eliminating the possibility of dark areas.

404—Baggage Rooms

RLM dome porcelain enameled steel reflectors with bowl enameled mazda lamps should in general be employed in baggage rooms. Average illumination requirements will be met with a provision of 4 foot candles.

405—Platforms

Platform lighting should be so arranged that the lamps and equipment are not objectionable to engine men coming into the terminal or passengers on the trains. Likewise, it should not prove an annoyance to those on the platform.

The distribution of light should be fairly uniform over the entire platform since the position of trains is not fixed. The number and location of outlets are governed by the type of structure, while the wattage per outlet is dependent upon the class of station.

Terminal platforms are in general provided with cover sheds from the roof of which the lighting equipment is suspended. One unit per bay mounted high enough to be clear of any truck load and providing from 1 to 2 foot candles furnishes very satisfactory illumination. RLM dome reflectors with bowl enameled lamps or

Fig. 401—Modern Terminal Waiting Room

if conditions warrant pendent lantern type fixtures are suitable for these locations.

There are two general types of way station platforms: first, the open type without a roof and second, the umbrella type which consists of an inverted V-shaped roof, supported by a line of columns on the center line of the roof. For the open type, iron posts of more or less ornamental design or reinforced concrete posts may be used to support the lighting equipment. RLM dome or shallow dome reflectors equipped with bowl enameled mazda C lamps which provide an average level of illumination of from 0.25—1.0 foot candles are recommended. The umbrella type platforms with columns spaced from 15 to 30 feet apart are well lighted when a single unit is provided per bay with RLM dome reflectors and bowl enameled mazda C lamps of size to provide an illumination of from 0.25 to 1.0 foot candles.

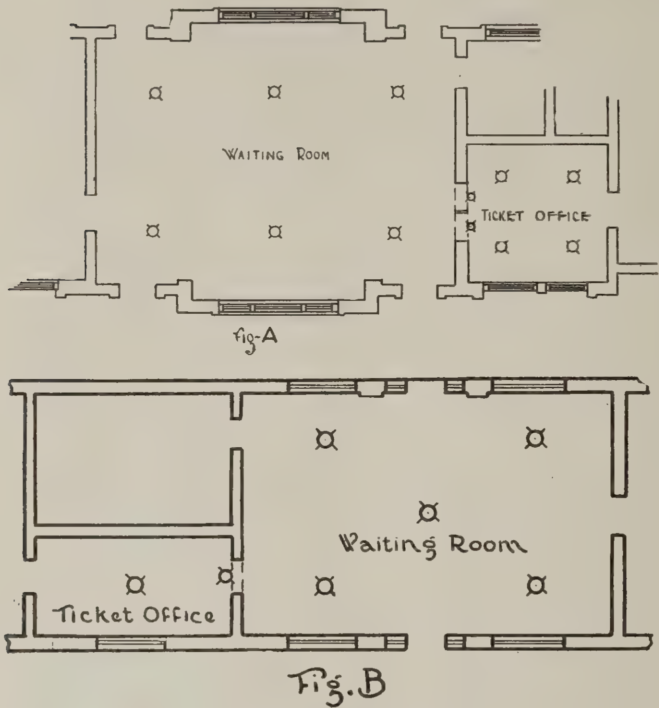


Fig. 402—Arrangements for Lighting the Medium and Smaller Types of Way Station Interiors

406—Subway

From an illumination point of view the most satisfactory arrangement of lighting units is to place them at the ceiling along the center of the subway and spacing them at intervals not exceeding 1½ times their height above the floor. An illumination of approximately 2 foot candles should be provided. Numerous types of equipment have been employed. Of these, RLM dome reflectors recessed in the ceiling and equipped with bowl enameled mazda lamps are probably considered the most practical. Enclosing luminaires mounted close to the ceiling are also being used to good advantage, while artificial windows with lighting equipment mounted in back have also proven highly satisfactory. This latter method is not, however, as efficient as the two overhead systems mentioned and it is therefore well to provide from 50 to 100 per cent additional wattage when this scheme is employed. Supplementary lighting should be furnished at the stairs in order that no deceptive shadows be cast on the treads. The equipment may be located in the hand rails generally found along the sides or in recesses in the sidewalls approximately 6 in. above the level of the tread. In either case it should be so arranged that the light will not shine in the eyes of pedestrians going up the stairs.

Location markers in the form of electric signs which serve as guides to the traveler are rapidly gaining in popularity in the railroad field. These should be of such a type that the lamps are not visible and the design in keeping with other architectural features of the building.

At the more important way stations the main station signs should be illuminated. For this service opalescent letter signs are preferred due to their pleasing appearance by day as well as by night.

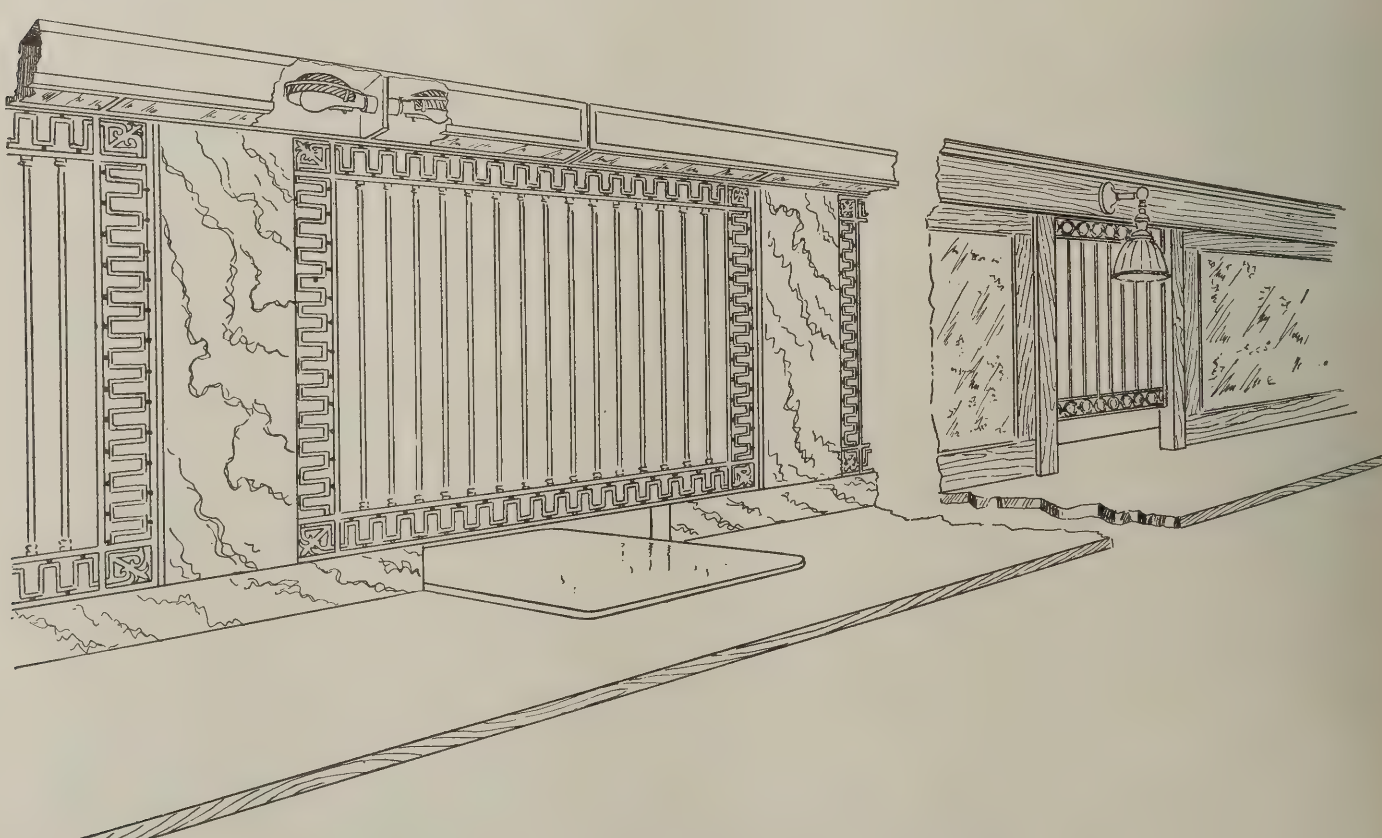


Fig. 403—Local Lighting Arrangements for the Ticket Window

Freight Stations
408—General

Without a doubt a large percentage of the loss in time and money caused by mis-sent goods may be traced directly to inadequate lighting. In the freight station it is essential that the freight be accurately checked, weighed and routed with a minimum of delay. Therefore, in such a location good lighting plays quite as important a part as in any other branch of railroad work and the increase in efficiency of the workers with the corresponding decrease in loss of goods will, in all probability, more than pay the installation and operating costs of a well designed lighting system.

In planning the lighting of a freight station it is necessary only to follow the fundamentals outlined in Section I.

409—Sorting Area

Sorting areas require sufficient illumination to provide easy reading of labels and other markings in both horizontal and vertical planes over the entire area. To accomplish this a straight overhead system of lighting will in general prove most satisfactory.

RLM dome reflectors equipped with bowl enameled mazda C lamps providing 4 foot candles furnish a satisfactory level of illumination. This equipment should be mounted fairly close to the ceiling in order to provide clearance as well as take advantage of the greater spacings permissible with higher mounting heights. The spacing between outlets should not be greater than 1½ times the mounting height of the unit above the floor if even illumination over the entire area is to result.

410—Loading Platforms

The one requirement for loading platform lighting is to provide sufficient illumination for easy and quick movement of freight to and from the box cars.

In general from 1 to 2 foot candles will provide very suitable illumination for the platforms. The outlet locations and lamp size are again governed by the ceiling heights. Spacing between outlets for this class of service should not exceed two times the distance of the light source above the platform. In the average type of building one unit per bay when mounted at the ceiling will be well within this limit.

There is at the present time quite some difference in the track and platform arrangements in the terminal buildings. In one arrangement a platform is located between every two tracks, while in another a single platform parallels all incoming and outgoing tracks. In the first type enough light filters over from the platform area to the tracks to permit the easy making up of the trains and cutting off of the cars in the terminals. For the latter type it is desirable to install outlets over the track area as shown in Fig. 407.

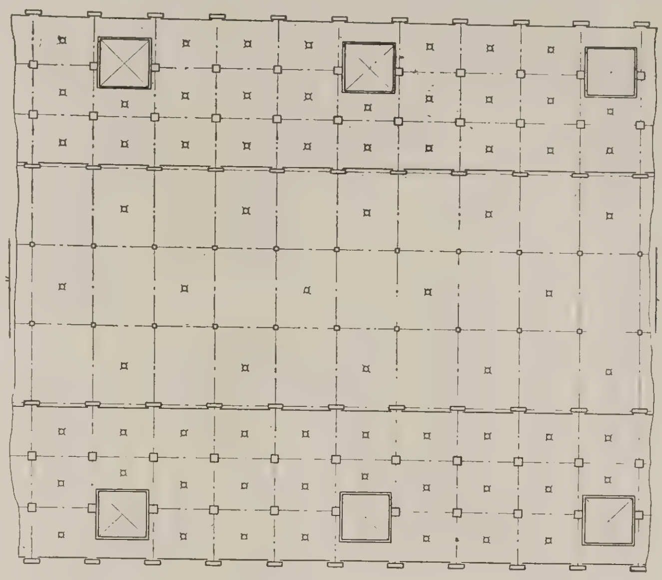


Fig. 405—Plan of Sorting Areas and Driveway Showing Location of Lighting Units

Fig. 404—Night View of a Medium Sized Way Station Lighted by Four 300 Watt Mazda C Lamps in Enclosing Luminaires

411—Storage Areas

Storage areas are satisfactorily lighted by general lighting systems employing RLM dome reflectors with the lamps providing

from 1 to 2 foot candles. It is desirable to install this equipment close to the ceiling in order to provide all the possible clearance for the piling of goods.

Due to the corrosive action of moisture, vapor proof equipment should be provided for the cold storage rooms.

412—Freight Offices

In conjunction with freight stations small offices are often encountered in which it is not desirable to employ lighting equipment of the types suggested in Section 3 due to the dusty and smoky conditions of the atmosphere around these areas.

In the unfinished offices, merely partitioned off from the Sorting area and Loading Platforms, RLM domes with bowl enameled lamps will suffice. In the better type offices where considerable clerical work is done enclosing luminaires are preferable. In either case an illumination level of approximately 10 foot candles should be provided.

The spacing distances given in Table 3A, Section 1, should be strictly adhered to in this location.

413—Freight Cars

Probably the most satisfactory method of lighting freight cars today is by means of 50 watt Mill Type lamps on extension cords which are provided with hooks to permit hanging in the cars. Typical equipment is shown in Fig. 409. These cords are generally run from socket receptacles placed along the track edge of the platform a trifle below the level of the car door. Where a number of tracks parallel each other the cords are joined by connectors or spliced so that they may be run through from one car to another.

While this form of lighting is not entirely satisfactory it appears, at the present time, to be the most practical for the purpose.

SECTION 5—Storehouses, Warehouses and Piers

500—General

Adequate lighting facilitates the movement of material. The proper illumination of warehouses and piers is in fact absolutely a necessity. Greater speed of trucking and better ability to read labels and markings on parcels will result under a proper lighting intensity, contributing directly in expediting transfers and shipments. Some of the indirect effects are fewer mis-sent shipments, reduction of spoilage and thefts and improved relations with the public.

501—Intensities and Wattage

A maximum of ¼ foot-candle intensity is given in the Illuminating Engineering Society's "Code of Lighting" for passageways, aisles and storage spaces, and has been adopted as mandatory in some states. This value takes care of the safety element alone and is not intended to represent the most conomical intensity, the code itself recommending that an average intensity of 1 to 2 foot candles be provided. Provisions for this higher value are now generally made in plans for modern warehouses and piers. An

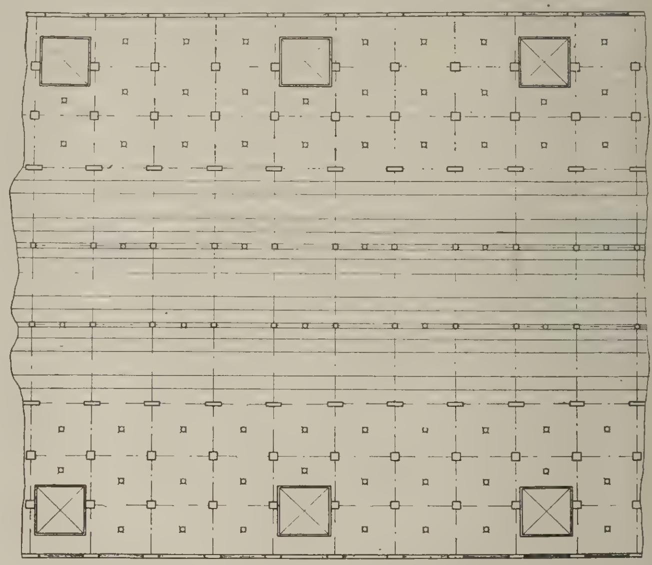


Fig. 407—Plan of Loading Platforms and Tracks Showing Location of Lighting Units

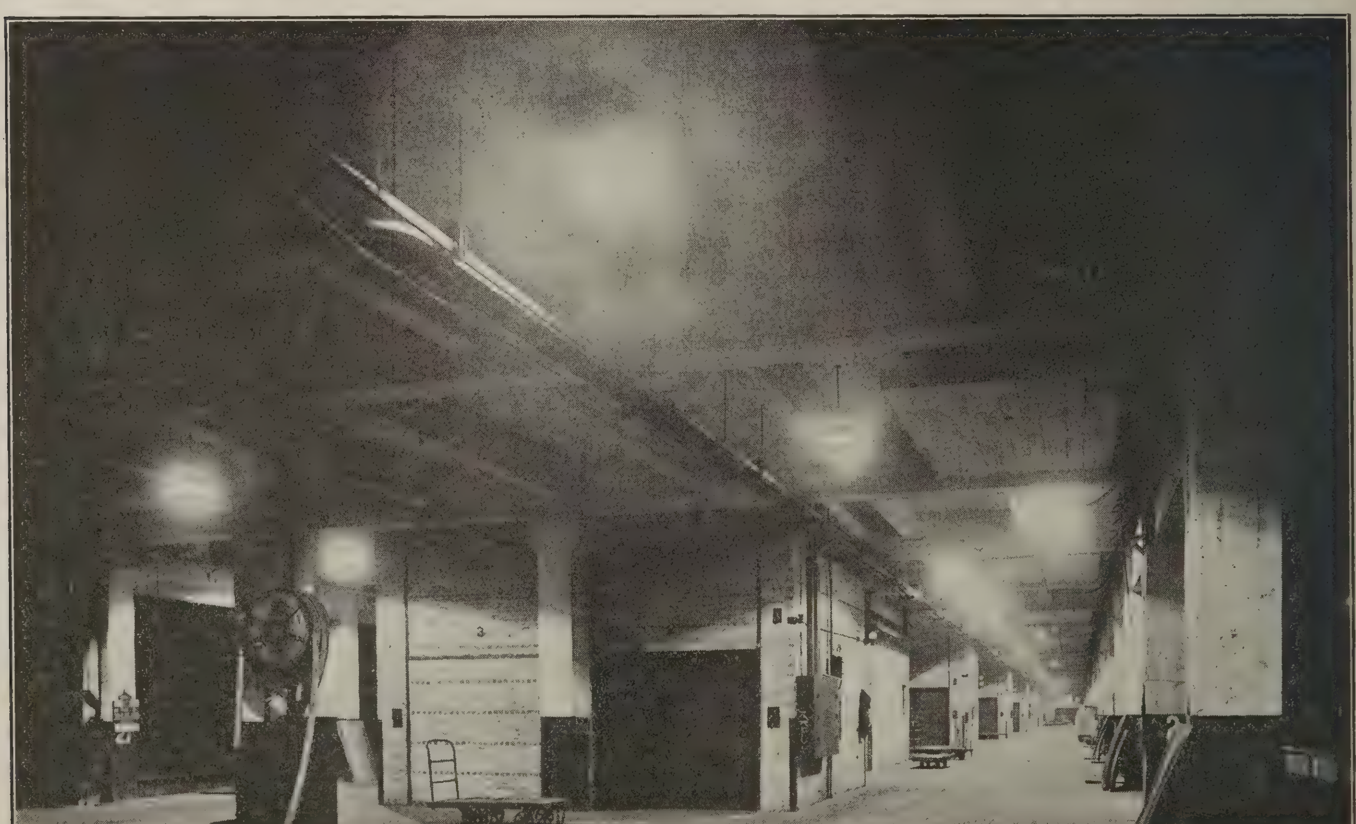


Fig. 406—Night View of a Loading Platform Lighted by One 200 Watt Bowl Enameled Mazda C Lamp with R L M Dome Reflector Located in the Center of Each Bay

average of at least 0.25 watts per square foot will be required to obtain this intensity.

502—Lamp Sizes

The size of lamp to be used will depend to a great extent on the area of the bays and the spacing of units. Where materials are piled high or where pipes or cross beams are present, dense shadows will result if large lamps, widely spaced, are used.

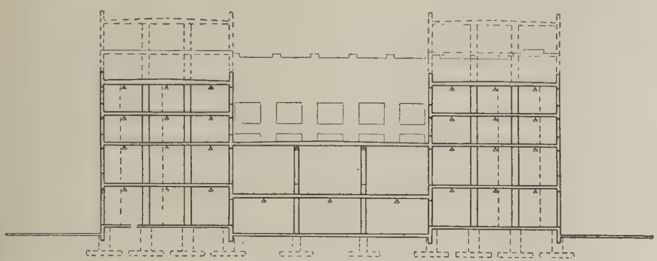


Fig. 408—Cross-Section of a Modern Freight Terminal

Smaller lamps spaced at closer intervals should be employed under such circumstances to assist in eliminating relatively dark areas and to give better diffusion. The 75, 100, 150 and 200 watt mazda C lamps are the usual sizes employed in lighting the average warehouse or pier.

503—General Lighting Plans

A system employing mazda C lamps equipped with RLM dome type reflectors is the recognized standard for lighting buildings

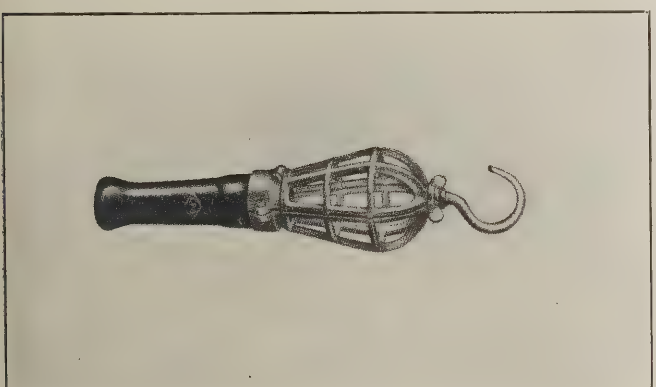


Fig. 409—Typical Equipment Employed in Lighting Freight Car Interiors

used for storage purposes. They should ordinarily be suspended in rows, spaced symmetrically with respect to bays, and mounted as high as possible. Properly applied, a higher mounting height permits of wider spacing, lessens the liability of breakage and reduces the possibility of glare. The units are usually spaced a distance equal to twice the mounting height. However, where even diffusion is placed secondary in importance to economy of installation and maintenance, a spacing as great as three times the mounting height is sometimes used. A row of units should be placed over the platform adjoining the track since this space is being continually traversed by the truckers loading or unloading freight. Outlets should also be provided for connection of extension lamps to illuminate the interior of freight cars as described under Freight Station Lighting (Section 4).

A typical system of illumination for a modern four track pier is shown in Figure 501. Each outlet consists of one 200 watt mazda C lamp, equipped with a standard RLM dome reflector mounted 15 feet above the floor. There are three rows of units above the storage space in each wing and one row over each platform adjoining the center trackage. In this layout an average of .29 watt per square foot is used, giving an average intensity of 1½ foot candles.

504—Fire Alarm Lights

Where fire alarm stations are installed in storage areas, it is quite important that they may be located quickly in an emergency.

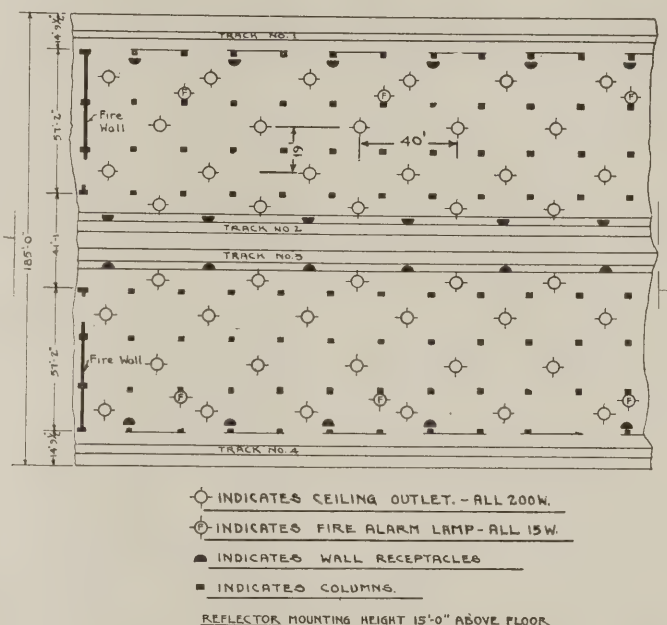


Fig. 501—Section of Modern Pier Showing Location of Lighting Outlets

The usual practice is to install at each station one 15 or 25 watt clear lamp equipped with a red enclosing bowl.

505—Exterior Lighting

On the water side of the pier an intensity of 1 to 3 foot candles should be provided for loading and unloading the ships. Units consisting of 500 watt mazda C lamps equipped with either angle type or RLM standard reflectors mounted about 30 feet above the pier and spaced on 40 foot centers will provide an average intensity of 2 to 3 foot candles within the area of operations. They should be located as high as possible and preferably recessed in pockets on the face of the pier, otherwise they are likely to be broken by the ship's boom during operations. The equipment should be weatherproof and vaporproof as it must withstand the attacks of smoke, gas and salt air.

NOTE: Sections 6 and 7 to be published later.

Report of Committee on Insulated Wire and Cables

Brief Reports from the Various Technical Committees Indicate Steady Progress Towards Standards

Committee:—

Francis J. White, secretary, Okonite Company; J. R. Sloan, chief electrician, Pennsylvania Railroad; L. S. Billau, assistant electrical engineer, Baltimore and Ohio; Ernest Lunn, chief electrician, Pullman Company.

TO THE MEMBERS:

We herewith submit the following progress report of the work of this Committee.

Technical Committee No. 1 on Definitions: A unanimous report was submitted presenting definitions of the A. I. E. E. This re-

port was approved by the Executive Committee and will shortly be transmitted to the Sectional Committee for their vote.

Technical Committee No. 2 on Conductors: This Committee submitted for approval A. S. T. M. Specifications B-3-15 for soft or annealed copper wire and B-33-21 for tinned soft annealed copper wire. The specifications submitted have been rearranged so as to comply with the standard form of this Sectional Committee and are now being circulated to the members of the Executive Committee for their criticism. Objection has been raised to the details of Specification B-33-21 on the grounds that the tinning test has not prescribed the number of dips now generally recognized as standard practice.

Technical Committee No. 4 on Rubber Insulation: This Committee has submitted four specifications which will shortly be sent to the Sectional Committee for their vote.

Technical Committee No. 6 on Varnished Cambric Cables: This Committee has submitted three specifications which have been approved by the Executive Committee. These will shortly be sent to the members of the Sectional Committee for their vote.

Technical Committees Nos. 3, 5, 8, 9, 10, 11 and 12: No formal specifications have been submitted by any of the above committees.

FRANCIS J. WHITE,
Secretary.

Report of Committee on Automatic Train Control

Train Control a Live Subject But Committee Feels That No Hasty Action Should Be Taken

Committee:—

F. E. Starkweather, chairman, electrical engineer, Pere Marquette; E. Wanamaker, electrical engineer, Chicago, Rock Island and Pacific; C. W. Nelson, supervisor of train control, Chesapeake and Ohio; C. J. Winslow, assistant electrical engineer, Michigan Central; Roy Liston, mechanical inspector, Atchison, Topeka & Santa Fe.

TO THE MEMBERS:

Your Committee has held two meetings during the year, one of these was a joint meeting with your Committee on Locomotive and Train Lighting, and have the following suggestions to submit:

A. Duplicate Headlight Generators

Your Committee does not favor the use of separate generators for headlight and train control. We favor the use of a single generator of ample capacity and of high grade construction, both with respect to its steam throttling and governing mechanism and also with respect to its commutator and brush construction and insulation; close voltage regulation, with a favored voltage at generator of 33 volts, with allowable variation of 1½ volts plus or minus.

Polarity of generator to be plainly designated on binding post on right, facing generator.

B. Location of Generator

We favor that generator be located on top of boiler, either transversely or parallel to the running board.

C. Conduit and Fittings

We favor use of water tight screw cover or gasket cover conduit fittings and joints made tight by the use of graphite grease or pipe compound in order that conduit system will be water tight except at lowest points and to drain these low points.

Conduit sizes larger than one inch should be avoided if possible.

Conduit runs to be kept at as high a level on the engine as possible to avoid over heating from torches or flare of tire heating equipment.

Conduit runs leading vertically downward to a junction box carrying terminals should be avoided, otherwise failure will result from dripping rusty water on terminal post.

D. Wire Terminals

We favor the use of No. 14-24 R. S. A. terminal posts with one-half inch hex nuts for the engine wiring.

E. Electro Pneumatic Valve

We favor the locating of E. P. valves in convenient place on boiler for readily accessible inspection and so as not to require an excessive amount of conduit, circuit wiring and air piping.

In general, the Committee feels that Automatic Train Control is a real live subject but that no hasty action should be taken or recommendations made.

Action Recommended

Acceptance as information.

Respectfully submitted,

AUTOMATIC TRAIN CONTROL COMMITTEE.

Report of Committee on Loose Leaf Manual

Material for Manual to be Included Only After Deliberate Consideration—High Standard to be Maintained

Committee:—

L. S. Billau, chairman, assistant electrical engineer, Baltimore & Ohio; J. A. Andreucetti, assistant electrical engineer, Chicago & Northwestern; G. H. Caley, electrical and signal engineer, New York, Ontario & Western; F. J. Hill, chief electrician, Michigan Central.

TO THE MEMBERS:

The Association at the 1924 convention authorized the establishing of a Manual of the Association to contain its standards, recommended practices, specifications, approved findings, etc., and to be published in loose leaf form. Your Committee was appointed to carry out this work with the following duties assigned to it:

1st—Determination of the form of the Manual, selection of style of binder, etc.

2nd—Review of the past Proceedings of the Association to select such subject matter as should be placed in the Manual.

3rd—Determination of method of procedure for revising the Manual from year to year to keep it up-to-date.

4th—Determination of the various details pertaining to the distribution of the Manual.

1—After carefully going over the different forms of Manuals issued by the various railroad associations your Committee has adopted the 6 in. x 9 in. size (same size as the Proceedings) and the same style of loose leaf binder that is used by the Mechanical Division and the Signal Section of the American Railway Association. This binder is of substantial construction, capable of withstanding constant use, and designed for readily inserting or removing any pages without disturbing the others. Its cost is also reasonable. The Executive Committee of the Association has approved the selection of the binder and size of pages.

2—After reviewing the Proceedings of the Association your Committee has selected the following subject matter as suitable for insertion in the first issue of the Manual:

(a) *Electric Train Lighting.* This includes the various standards and practices that have been developed by the Association and the standard specification for axle generator equipment. The Committee on Illumination has in its work established some

standards pertaining to train lighting lamps and lamp positions with respect to reflectors for use in car lighting fixtures which has been included in this car lighting section.

(b) *Electric Headlights and Locomotive Lighting.* This includes such standards, definite recommendations pertaining to electric headlight practices, etc., that have been developed by the Association.

(c) *Motors and Control Equipment.* This includes only the specification for motors for industrial uses that has been adopted by the Association.

The first edition of the Manual will be known as the 1925 edition, and will contain the subject matter taken from the past Proceedings and such additional matter as may be presented by the committees in their reports for this year.

There are other specifications that have been adopted by the Association, such as for incandescent lamps and for insulated wire but which are now considerably out of date and, therefore, it is felt should not be placed in the Manual. There are other recommended practices and conclusions that possibly properly should be in the Manual but because of being more or less out of date or otherwise incomplete your Committee has decided to omit them from the first issue and let them be taken up by the Association in the future as new work.

3—After having established the Manual, the worth of the Association to the railroads and possibly later on the justification for continuing the existence of our Association may depend largely upon what is published in the Manual. It is, therefore, highly important, in fact essential, that the Manual be maintained at a high standard. It is felt that recommended construction and maintenance practices, specifications, important findings and conclusions that are developed by the Association should not be placed in the Manual until after receiving thorough and deliberate consideration to insure that they reflect only the best practice. It is not expected that all of the committees will have subject matter for the Manual every year and its growth will, and preferably should be slow but sure.

With this object in view your Committee recommends the following procedure for maintaining the Manual:

1st—Each committee in the future is to include as a distinct part of its annual report (a) what changes, if any, should be made in the subject matter already published in the Manual pertaining to its work, (b) what obsolete or superseded matter should be withdrawn, and (c) what new matter should be added. As your Committee had no authority to make changes in existing standard practices, etc., it recommends that each committee concerned, carefully review the subject matter coming under its jurisdiction that will be presented in the first edition of the Manual and submit in its 1926 reports such changes as it deems desirable.

2nd—As a permanent committee on Manual it is proposed that it comprise the Executive Committee of the Association and Chairmen of the various committees. Its duties will be to pass upon the changes, additions or withdrawals that have been submitted in the reports presented at the annual conventions.

Where this committee does not agree to these recommendations they shall be referred back to the committee in question for further consideration and reported again to the Association in the following year's report. The Manual Committee shall have the authority in editing the subject matter that is to be placed in the Manual, to change the wording or arrangement to conform to the style of the Manual without reporting back to the committees as long as the sense of recommendations is not altered.

Respectfully submitted,
COMMITTEE ON LOOSE LEAF MANUAL.

Report of Committee on Railway Stationary Power Plants

Progress Report Points Out Causes for Lack of Economies in Average Railroad Power Plant

Committee:—

J. E. Kilker, chairman, Missouri Pacific; Ernest Marshall, electrical engineer, Great Northern; C. G. Winslow, assistant electrical engineer, Michigan Central; C. P. Kahler, electrical engineer, Oregon Short Line; B. L. Thompson, assistant superintendent terminals, Norfolk & Western.

TO THE MEMBERS:

Much valuable information and data has been compiled and presented to the Association by members of previous Committees on Power Plants. It is regrettable that the Committee selected to report on Stationary Power Plants was unable to function. Several attempts were made to have the Committee get together so that the various phases of this subject could be discussed and the work assigned to the Committee planned. For reasons beyond the control of the members of this Committee, we were not successful in getting together.

Railroad stationary power plants offer a field for close study and investigation, both in regard to selection of economical equipment for new plants and methods for maintenance and operation to produce higher efficiencies. The power plant should have the same consideration and study as to design, installation, and operation as that given to motive power. Without an adequate and constant supply of energy in the form of mechanical power, electric power, compressed air, steam for heating and other purposes, the maintenance of rolling stock and motive power would be seriously impaired. It is obvious, therefore, that the stationary power plant is of vital importance in connection with railroad maintenance facilities.

Vast sums of money are spent annually by the railroads for the operation of their steam plants, which if properly designed for the purpose they are to serve, would save in many cases, thousands of dollars. When considering shops and terminal facilities, regardless of size, the same care and study should be exercised in designing the power plant as is given to locomotives and many other equipments on the railroad. The power plant is no place to utilize worn out and scrapped equipment reclaimed from other departments, and the practice of utilizing old locomotive boilers in stationary plants should be discouraged. No fixed rules can be laid down to govern the design of all plants. Each plant must be laid out and designed for the facilities it is to accommodate. Efficient equipment which will produce the most economical operating condition should be selected. Great economies are realized where the surplus exhaust steam, above that required for heating the boiler feed water, can be applied to the heating of buildings.

It is conservatively estimated that one pound of steam used first in an engine or turbine, and then in heating system will replace one and one-half pounds of steam required where the engine or turbine is run condensing and live steam is used in the heating system. In large plants having a sufficient volume of exhaust steam available, and not required during the summer period for heating, can effect economies by installing mixed pressure bleeder type turbines. With this type turbine, steam at low pressures can be extracted for heating during the winter months, and during the period when heat is not required, all available exhaust steam for hammers, pumps and auxiliary equipment (except that required for heating feed water) can be reclaimed and used in the low pressure stage of turbine. High operating efficiencies can be attained in this manner.

With few exceptions, our present-day railroad stationary plants are composed of scrapped locomotive boilers and other obsolete equipment, excluding the larger plants erected in recent years in connection with modern shops. The low efficiency and excessive cost of operating these obsolete plants has created a condition that has made it possible for the central power station to offer the railroads their service at a figure that appeared very attractive. Many plants have been closed down and power is being purchased from these central stations which in a great many cases, has resulted in a higher cost than the operation of the steam plant.

Rates for power as offered by most central station companies are somewhat misleading due to the intricate rate structure. Where

terminal and shop facilities are required, it is as a general rule, necessary to provide a steam plant to supply the facilities. Assuming this as a fact, and that terminal buildings require heat during the winter season, a modern stationary plant can, in most cases, be installed and will supply all facilities at a less cost than would result by securing power from Central Station Service.

I have in mind two plants that are very similar in all respects. In one of these plants, all power is generated within the plant, this includes electric power, compressed air, and steam for various purposes, while in the other plant, electric power is purchased, air compressor is electrically driven, and steam plant is used to supply steam for hammers, and various other purposes. The total load carried by both these plants will approximate 1300 kilowatts. It may be surprising to know that the cost of purchased power alone is considerably greater in the second plant, than the total cost of operating the first plant, in which the equipment is more or less obsolete, having been in service more than twenty years.

No doubt, there are many conditions under which central station service is desirable and economical, but from data I have been able to secure, I am led to believe that improper analysis of conditions and requirements and the desire to shirk the responsibility of steam plant operation, has resulted in the abandonment of many stationary plants and the purchase of electrical energy at increased cost.

Railroad stationary plants are usually subject to more neglect than any other equipment on the railroad. Equipment not maintained in an economical working condition and as a rule, repairs are not made until the plant fails. There are means by which economies can be effected, in many cases, in our power plants, that will result in vast savings to the railroads if the necessary effort is put forth to apply these means.

Much valuable data pertaining to stationary power plants has already been presented to you and I regret the inability of the present committee to continue to carry on this good work.

Respectfully submitted,

COMMITTEE ON RAILROAD STATIONARY POWER PLANTS.

Report of Committee on Safe Installation and Maintenance of Electrical Equipment

An Outline of Procedure Suggested to Prevent Injury from Contact with Electrical Circuits

Committee:—

L. F. Miller, chairman, road foreman electrician, Chesapeake & Ohio; F. G. Baker, electrical engineer, St. Louis & San Francisco; C. E. Moring, electrical engineer, Southern Pacific; A. M. Frazee, electrical engineer, Duluth, Missabe & Northern.

TO THE MEMBERS:

This report is intended to lay particular stress on the safety features involved in the installation and maintenance of electrical equipment and apparatus. The rules and practices recommended herein are not intended for the guidance of electrical workers alone, but they apply equally as well to machinists, millwrights, oilers and others who work around machinery operated by motors or other electrical apparatus.

Installation

GENERAL

First: All new work should be installed in the safest way possible.

Second: Existing installations should in all cases be brought up to safety standards as soon as possible.

Third: All work must be in accordance with the rules and regulations of the "National Electric Code," prepared by the National Board of Fire Underwriters, as issued, revised and in effect from time to time hereafter and such local ordinances as may be in effect where the installation is being made.

Fourth: All conductors, however well insulated, should be treated as bare, to the end that under no conditions, existing or likely to exist, can a ground or short circuit occur, and so that all leakage from conductor to conductor, or between conductor and ground, may be reduced to a minimum.

Fifth: In all cases where a ground connection is required, it is recommended that these connections be made to a cold water pipe, which is known to form a permanent and positive ground. If a cold water pipe is not available, it is recommended that a ground connection be made by driving not less than a three-quarter-inch galvanized pipe, or its equivalent, in the ground a sufficient depth to insure a permanent ground. If the nature of the soil does not insure a permanent ground by the foregoing method, the specifications as given by the National Electric Safety Code (published by the Bureau of Standards, Washington, D. C.) are recommended. In all cases, approved ground clamps are recommended.

Sixth: It is recommended that all new inside installations shall be made in approved conduit or approved armored cable, and when extensive repairs are made to old installations of open wiring, conduit shall be substituted.

Seventh: It is recommended that all high voltage wiring (601-5,000) shall be in approved lead cable or armored cable, run in conduit where used for interior work.

Eighth: The term commonly referred to as "CONDUIT" in this report, is intended to include all kinds of approved metallic conduit.

Ninth: Where any installation is not covered by the above, use good judgment to make it safe.

EQUIPMENT AND MATERIAL

First: Use only such equipment and material which is inspected and approved by the Underwriters' Laboratories and which as far as practicable incorporate safety devices which will protect both operator and equipment.

Second: In consequence of liability involved by accident, primary consideration should be given to the safety features rather than to the first cost.

GENERATORS

First: All electric generators and supply equipment shall have the exposed non-current carrying metal parts permanently grounded. This to include frames of generators, switchboards, transformers, lightning arrestors, enclosed switches and operating levers. However, this rule does not necessarily apply to d.c. generators having one pole grounded.

Second: Flywheels and belts should be guarded. Flywheel pits should be covered or guarded.

SWITCHBOARDS—Power panels or sub-stations. (Not distribution panels.)

First: All systems should be of the dead front type.

Second: All switches on circuits above 300 volts should be the oil type, preferably having separate cells for each pole and have proper disrupting capacities in order to insure the performing of its functions with safety and properly protect the apparatus to which they are connected.

Third: Care should be taken in using only pure mineral oil having the following characteristics:

Where not subjected to a temperature below zero degree C., 32 deg. F.

Flash point, 185 deg. C.
Burning point, 210 deg. C.
Freezing point, 10 deg. C.
Viscosity at 49 deg. C., 105 sec.

Where oil switches are installed in unattended places or unheated buildings, in outdoor installations or on pole lines, the oil should have the following characteristics:

Flash point, 155 deg. C.
Burning point, 180 deg. C.
Freezing point—40 deg. C.
Viscosity at 40 deg. C., 80 sec.

Fourth: Automatic overload circuit breakers should be installed between generator and switchboard busses.

Fifth: All feeder circuits should be protected with automatic, inverse time limit overload oil switches.

Sixth: Switchboards should be so installed that there will be ample space between conductors and wall to permit workmen to make repairs with safety, this space to be enclosed behind locked doors.

Seventh: All existing switchboards not provided with dead fronts should have rubber mats in front and rear of same.

Eighth: Fuses are not recommended where automatic circuit breakers can be used.

MOTORS AND CONTROL EQUIPMENT

First: Strict conformance to the National Electric Code is recommended. Also local ordinances, where equipment is installed.

Second: Each equipment should be provided with separate safety disconnecting knife switch to disconnect both control and motor from line so repairs may be made with safety.

Third: All power lines supplying current to a motor must be dead on the load side of controller or starter when starting apparatus is in the "off" position.

Fourth: All controllers with exposed live parts should be enclosed in safety cabinets, with doors so arranged that only authorized persons may have access to same.

Fifth: Motor-starting rheostats should be enclosed in metal cabinets, with handles for external operation.

Sixth: All protective devices used in connection with motor control apparatus should be provided with full magnetic or thermal overload and under-voltage protection with hand reset, except where used on automatic equipment it need not be hand reset.

Seventh: Where motors are so installed that there is a liability of accident, adequate guards should be placed around same to protect workmen. This to include belts, gears or other transmitting devices.

Eighth: Hand-operated starters and push-buttons of remote control starters should be within sight of the equipment controlled, unless such equipment is within an enclosure.

Ninth: Where motors drive line shafts or particularly dangerous machinery, such as planers in wood mills, elevators, etc., it is recommended that emergency stop stations be provided in accessible places so the equipment may be stopped in case of an accident. It is further recommended that there shall only be one starting station.

Tenth: The frames of all motors and each piece of control equipment must be thoroughly grounded.

Eleventh: Caution placards admonishing danger should be conspicuously placed at such a location as to warn employees and others of the presence of high voltage and equipment.

WIRING

First: Strict conformance to the National Electric Code is recommended.

Second: It is recommended that all new installations be made in conduit.

Third: Special attention should be paid to the mechanical execution of the work, careful and neat rewiring, connecting, soldering, taping of conductors, securing and attaching of conductors and fittings are especially conducive to security and efficiency.

Fourth: In laying out an installation, every reasonable effort should be made to secure distribution centers located in easy accessible places, at which points cutouts and switches controlling the several branch circuits can be grouped for convenience and safety of operation. The places selected for cutouts and switches should at all times be kept clean and accessible and the piling of boxes or storing material in front of same prohibited. The load should be divided as evenly as possible and all unnecessary wiring avoided.

Fifth: It is recommended that all high voltage wiring (601-5,000) shall be run in approved lead or armored cable, run in approved conduit, where used for interior work.

Sixth: The installation of extra high potential circuits is adequately covered by the Code.

Seventh: It is recommended that in wiring for light circuits, the number of outlets on any branch shall not exceed seven and preferably be limited to six. This number of outlets is limited because experience has proven that it is a very hard matter to prevent the application of higher wattage lamps than that for which the circuit was originally intended and wired for.

Eighth: It is recommended that all single phase lighting circuits from 30 amp. to 100 amp. be run as a three wire circuit, using an unfused, grounded neutral. Branch circuits may be run either as a two or three wire system. Where the load exceeds 100 amp., it is recommended that a three phase system be used.

Ninth: The use of fuses for the protection of motors is not recommended.

Tenth: (a) Entrance and branch line fuses must be provided as required by the National Electric Code, but where it is practicable to install automatic circuit breakers, they are preferred. The selection of circuit breakers to be governed by local conditions.

(b) In lighting circuits, the use of fuses is satisfactory when installed according to the National Electric Code.

(c) The capacity of the fuse should never exceed the capacity of the wire which they are to protect.

(d) One time or refill fuses. It is recognized that both types of fuses, when properly installed and maintained, perform the functions for which they were intended. It is further recognized that both types have characteristics both favorable and unfavorable and the type of fuse to be used depends largely upon local conditions, as well as the class of supervision and inspection maintained. This committee does not deem it advisable to recommend either type exclusively, as either type will protect operator when properly installed and maintained.

(e) All switches must be so designed that when installed the blades will drop open, and when of the fused type, the fuse must be on the hinged side of switch. In this design of switch the blades and fuses will be dead at all times when the switch is open.

Eleventh: No circuit shall be on more than one switch. It has been found in several cases where a line will have two or three switches feeding it, and an employee will pull one switch and still the line will be hot.

PORTABLE EQUIPMENT

First: For portable equipment, other than small hand lights, it is recommended that armored cable or additional wire be used for grounding the machine. When armored cable is used, it must be so connected that it will form a grounded connection to the conduit system.

Second: Safety type receptacles are recommended for connecting all portable power apparatus, such as welding machines, rivet heaters, etc., operating on a voltage of 220 or higher. By "safety" type receptacles is meant one which will embody the following features in combination with a switch or disconnecting device:

(a) The device cannot be connected to the receptacle unless the switch is open.

(b) The connecting plug cannot be withdrawn from the receptacle until the switch is opened.

(c) The switch cannot be closed unless the plug connection is connected with the receptacle.

(d) The plug should be provided with a grounded connection so that the ground conductor from the portable motor or device can be attached in a safe and effective manner.

Third: Transformer type welding machines should be equipped with an automatic over-voltage release which will limit the voltage across the welding leads to not more than 60 volts, when the arc is broken or circuit is open. The iron core of transformer should be grounded similar to the frame of portable motors.

Fourth: For portable extension hand lights, it is recommended that composition or other well-insulated sockets of the keyless type be used in connection with wooden handles or other insulating material to which is attached a well-constructed guard.

MAINTENANCE

First: In the maintenance of electrical equipment, it is recommended that thorough systematic, periodic inspection be made and any improper or irregular condition found, correction shall be made immediately.

Second: Equipment shall be kept thoroughly dry and clean.

Third: When each inspection is made, it should include the supports sustaining the equipment which should be kept secure and rigid. All power transmitting devices such as belts, gears, etc., should be included in this inspection.

Fourth: The inspector should see that all circuits are properly fused and overload relays properly set, and operative.

Fifth: It is suggested that there must be at least two employees present when repairs are being made to high tension apparatus or lines.

Sixth: All motors operating turntables, elevators, transfer tables, line shafts or other machinery where a repairman is likely

to be working concealed from view of the control station, a safety switch must be provided so the workman can lock it open before such work is started.

Seventh: Before any work on cranes or their runways, the crane operator must be notified by the workman. A form might be provided for that purpose or simply a written note. The operator should sign the form which will be kept by the workman until repairs are made.

Eighth: For the safety of repairmen and others the following suggestions are furnished:

Don't work on live circuits except when absolutely necessary, then take proper precautions.

Don't work on high tension apparatus until you are sure it is disconnected from the line and grounded.

Don't lay tools where they are liable to fall and cause damage or accident.

Don't feel a circuit to see whether it is alive or not. Use a meter or test lamp instead.

Don't wipe, oil or adjust a machine while in motion.

RESUSCITATION

It is recommended that in case of a severe electrical shock the Prone Pressure Method of Resuscitation as prescribed by the Commission on Resuscitation from Electric Shock be adopted and that placards, similar to No. 1352, issued by National Safety Council, Chicago, showing the method of application and treatment, be framed and conspicuously displayed at prominent locations throughout the shops. It is further recommended that all foremen throughout the shops thoroughly acquaint themselves with this method of resuscitation and that the employees generally be encouraged to practice this method according to instructions. A pamphlet containing rules of resuscitation can be obtained from the National Electric Light Association, 29 West 39th street, New York, at a nominal price.

Respectfully submitted,
COMMITTEE ON SAFE INSTALLATION AND MAINTENANCE OF ELECTRICAL EQUIPMENT.

Report of Committee on Locomotive Electric Lighting

Recommendations for Turbo-Generator Equipment To Be Used in Connection With Automatic Train Control

Committee:—

L. C. Muelheim, chairman, chief headlight supervisor, Baltimore & Ohio; J. L. Minick, assistant engineer, Pennsylvania System; P. J. Callahan, supervisor car and locomotive lighting, Boston & Maine; O. W. Sparker, supervisor electric headlights, New York Central; E. Wanamaker, electrical engineer, C., R. I. & P.; F. J. Hill, chief electrician, Michigan Central; Jos. A. Cooper, assistant electrical engineer, Wabash.

TO THE MEMBERS:

Conditions have made it impracticable for meetings of your Committee to be held since its reappointment, with exception of a joint meeting with the Committee on Automatic Train Control which was held on August 5th.

At this meeting the principal subject under consideration was in connection with the design of the turbo-generator for use with Automatic Train Control Equipment, which subject your Committee has been instructed to investigate. With the constant change in the state of the train control situation your Committee feels that while it would be inadvisable to attempt to develop a complete specification for a generating unit at this time it is entirely practicable to recommend a tentative specification to cover at least such general features as capacity, voltage, allowable variation, etc.

Experience thus far indicates that duplicate generators, or one generator for the train control system and one for the headlight system is not necessary, and that one generator, of high grade construction, properly installed and maintained, is more satisfactory as well as being more economical. The design of the turbo-generator should include ample capacity, which experience shows should be in the neighborhood of 750 watts. The voltage rating should be 32 volts, in line with the rating of the present generators for headlight service, and maximum allowable variation should not exceed 1½ volts above or below normal throughout a steam pressure range of 100 lb. minimum and 250 lb. maximum for train control. For equipment of the continuous inductive type a freedom from any pulsation or ripple in the voltage wave is essential and the generator should therefore be so designed as to produce a smooth voltage wave, reducing any voltage irregularity to the minimum. The features mentioned, as well as those of a terminal box and generator terminals marked as to polarity, should of course be in addition to the present American Railway Association Mechanical Division, adopted standards with respect to supporting feet, bolt spacing, steam piping, ball bearings, lubrication, brushes, etc., which features were among the early recommendations of your Committee and were adopted by the American Railway Association in 1920, revised in 1922 and are at present the recommended practice of that association.

Your Committee therefore recommends the following as standard practice for the turbo-generator used in connection with automatic train control equipment:

The turbo-generator should be not less than 750 watts capacity and should be capable of developing normal voltage of 32 volts and full load at a steam gage pressure of 100 lb., the governor to regulate the speed of the turbine properly between steam pressure range of 100 lb. minimum and 250 lb. maximum without the necessity for change of nozzle or governor parts. Maximum voltage variation should not exceed 1½ volts above or below the normal of 32 volts throughout the steam pressure range of 100 lb. minimum and 250 lb. maximum. Characteristics of the generator should be such as to produce a smooth voltage wave, reducing any voltage irregularity to the minimum. The generator should be totally enclosed, with exception of such openings as may be required for necessary ventilation, and such openings should be so arranged as to exclude dirt and moisture from the generator interior. Generator leads should be flexible and terminate in a suitable terminal box made integral with the generator casing, terminal box to be provided with No. 14-24 R. S. A. standard terminal posts with ½-inch brass hex nuts. Terminals should be plainly marked for polarity, right hand terminal posts being Positive and left hand terminal posts Negative when standing facing terminals.

Turbo-generator to have three (3) feet for support and attachment to base plate, thickness of feet at bolt hole to be ¾-inch and ribbed on sides to engage head of bolt to prevent turning, ribs to extend to body of turbo-generator to strengthen the feet, holes in feet to be 11/16-inch diameter for ⅝-inch bolts, bolts to enter from the top with nuts on under side of base plate. Bolt hole spacing to provide for 1 bolt at generator end on longitudinal center line of turbo-generator, 5 inches from transverse center line and 2 bolts at turbine end on opposite sides 4½ inches from longitudinal center line and 5 inches from transverse center line.

Where clearance between foot and body of turbo-generator prevents entering bolt from top, foot may be slotted, but where it is necessary to slot all feet slot in foot at generator end should be parallel with longitudinal center line and slots in feet at turbine end parallel with transverse center line.

Steam inlet of turbine to be for ½-inch iron pipe, exhaust outlet to be for 2-inch iron pipe and drain to be for ½-inch iron pipe.

The variation in location of steam inlet from longitudinal and transverse center lines of bolt spacing, and the distance above the base plate to be in increments of ½-inch, steam inlet to be on left side facing turbine end.

Ball bearings to be any of the following numbers, which also designate the size:

No. 306 No. 308 No. 406

Lubrication for turbo-generator to be oil.

Brushes to be 1-inch wide, ½-inch thick and not less than 1½-inch long.

Brush holders to be equipped with springs so designed that no adjustment is necessary or possible during the full life of the brush and commutator and to provide uniform pressure during 1-inch

wear of brush. Brush holders to be machined inside, set 3/32-inch from commutator and at an angle of 10 degrees.

Screw sizes smaller than No. 12-28 thread not to be used, heads to be either fillister or flat and material to be brass or steel. For sizes larger than No. 12 use ¼-inch, 5/16-inch, ⅜-inch, etc., bolt sizes, heads of ¼-inch and 5/16-inch bolts to be slotted to permit use of screw driver.

The turbo-generator should be located as near the cab as practicable, preferably set longitudinally with the boiler, on left hand side, with generator end toward the locomotive cab and in a position so as not to obstruct the vision of the fireman. Where conditions will not permit location of the turbo-generator in this manner, it should be placed on the top of boiler with generator end preferably toward the left side.

The matter of photometry of headlight reflectors has been investigated somewhat further but no development of sufficient importance to be reported as definite progress has occurred. This matter should be carried over another year, during which time it is expected definite conclusion can be reached with respect to the detail method of photometry that should be adopted as standard practice.

No further development in the matter of a fixed focus for locomotive headlights has been reported to your Committee by the advocates of this practice, but if further experiments are being carried out on any of the roads the results should be made known for the benefit of the Association.

The subject of wire for locomotive service, which was one of the matters formerly before this Committee, is this year being handled by the Committee on Wire and Cable, and the subject of lamps for locomotive service is being handled by the Committee on Illumination. As a matter of information, however, it may be said that the 100 watt lamp for yard locomotive service has now been standardized in the P-25 bulb to supersede the G-25 bulb. The P-25 bulb lamp will be furnished automatically when present stocks of the G-25 bulb are exhausted.

Respectfully submitted,

Committee on Locomotive Electric Lighting.

Report of Committee on Train Lighting Equipment

Third Rail Clearances and Other Factors Will Not Allow Further Change in Battery Box Dimensions

Committee:—

A. E. Voigt, chairman, car lighting engineer, Atchison, Topeka and Santa Fe; L. S. Billau, assistant electrical engineer, Baltimore and Ohio; J. L. Minick, assistant engineer, Pennsylvania Railroad; F. O. Marshall, assistant superintendent yard department, Pullman Company; E. S. M. Macnab, engineer car lighting, Canadian Pacific; R. E. Gallagher, assistant electrical engineer, Louisville & Nashville; J. J. Hack, engineer train lighting, heating and ventilation, Southern Pacific; A. E. Ganzert, car lighting supervisor, Chicago, Rock Island & Pacific; H. G. Myers, electrical foreman, Atchison, Topeka & Santa Fe.

To the Members:

AXLE LIGHT EQUIPMENTS

All manufacturers of axle light equipment are advocating potential or modified potential control. The committee, therefore, thought it well to cover some fundamental principles that should be observed to get the best results with this method of control.

Cables of sufficient size between generator, generator regulator, and battery should be used in order to reduce the drop, thereby insuring a greater output at a given voltage. This is of greater importance where one does not use a lamp regulator, and on this account desires to keep the voltage as low as possible, to protect the lamp and at the same time be assured of generating sufficient current to keep the battery charged. We therefore suggest that No. 2 cable be used on all such wires, except the field wires.

It is also desirable to keep down the drop in the battery connectors. For this reason, we would suggest that connectors should be burnt on or where bolted, should be spot welded or soldered, to insure a minimum drop. For battery connectors, one road uses a standard rubber covered copper connector, with a moulded lead terminal cast on, the lead terminal being crimped around the rubber covering on the battery connector to keep out the acid. In applying these connectors, they use the short circuited current from four cells of the battery to burn on the connectors. This is accomplished by the use of about 10′ of heavy flexible cable connected to a carbon holder on one end and a suitable clamp on the other. By this method a good connection can be made in less time than where bolts are used, and such connection is free from corrosion. After one has done all that is possible to keep down the drop in voltage, and has given consideration to the size of battery, lamp load, length of run and lay over, and have adjusted your regulator accordingly, the only possibility of overcharging the battery, provided your regulator is functioning properly, is due to a shorted cell. To guard against this, one should keep a record of flushings and when it is noted that a battery is being flushed too often, considering the service it is in, the operation of the regulator should be checked and the battery examined for a shorted cell.

Automatic Switch

It is also essential to have an automatic switch that is reliable, in closing on a given voltage, there being little change in the closing voltage between hot and cold. Where you do not have a reliable automatic switch, and you adjust your regulator for 36½ or 37½ volts your equipment will not generate. In case of the failure of the switch to close on the voltage for which it is adjusted, the regulator will be warm and will answer most tests, which is deceiving to your inspectors. Where the automatic switch is reliable, it is of assistance to your lamp regulator, and reduces the possibility of pumping. In case you do not use a lamp regulator, a sudden change or jump in voltage, which is quite often noticeable to passengers, is avoided.

Adjustments

Investigation will disclose that we have two classes of service to operate cars under; the short runs with long lighting hours, and the longer runs with reasonable lighting hours. There are several ways that we can take care of the hard runs referred to, namely by use of large machines with low full load speed, by increasing the size of the battery, which will enable you to put more current into the battery at a fixed voltage. While this method increases your first cost on equipments, your maintenance is reduced due to your not working the battery so hard. The other method is to raise your voltage setting. On account of it being desirable to change the voltage setting, due to short runs, also the possibility of a sulphated battery, we feel that there should be visible means of changing the voltage adjustment of a regulator, without a trip on the road. The various manufacturers have accomplished this in different ways.

Belt

With the introduction of the clasp brakes, the committee feels that it should call attention to the possibility of using the Walker or Safety type of belt fastener, which in the past has not been possible on truck mounted generator, due to lack of clearance. One road recently made a test of two belts, using Walker fasteners on two Pullman cars operating in hard service, where the climatic conditions varied. One belt made a total of 121,411 miles; the other belt made a total of 142,310 miles up to May 31st. I think it is generally accepted that the big problem of drive is the belt fasteners, and if we are to increase our belt mileage and reduce our failures, it is necessary that we improve the weakest point in the drive, which is the fastener. Aside from securing a fastener where the cracking of clamps is reduced to a minimum, it is also essential that the rebound of the generator

be taken off of the belt on sudden stops, especially on the more modern trains, where they are handling all the way from 15 to 17 cars per train. The method that has been adopted on one road was covered in the paper last year and they state that this is satisfactory.

Dynamo Pulleys

To further protect the belt at the clamp, wish to call attention to the fact that the Rubber-on-Metal Corporation are in a position to take an old dynamo pulley, and resurface same with a coat of hard rubber. This has the tendency to reduce the slippage and would also permit less tension on the belt. They claim that in applying this rubber they apply a sufficient amount of it to give you two turnings on the dynamo pulley and claim that the rubber crown, due to their reducing the slippage of the belt, will last twice as long as that of a metal crown. Several roads are trying out these pulleys and will be in a position to give more definite data at a later date.

Suburban Coach Lighting

Your committee last year referred to this subject and stated that various roads were meeting this in different ways. We would like to call for an expression from the roads that have gone into this stating just what equipment was used and results accomplished.

Your committee wishes to recommend to the Train Lighting Committee of the A. R. A. that postal authorities be requested to confer with the committee on train lighting of the A. R. A. before issuing specifications or making any changes in the specifications on Postal Car Wiring.

Battery Box Dimensions

Last year the following changes in standard battery box dimensions, as adopted by both this association and by the American Railway Association were recommended and approved by this Association:

Height in clear from 21½ inches to 24 inches.

Depth, front to back from 25 inches to 31 inches.

Length of compartment to hold two standard double compartment trays from 22⅝ inches to 23⅝ inches.

Length of compartment to hold four standard double compartment trays from 3 ft. 9½ inches to 3 ft. 11½ inches.

Size of cable between regulator, dynamo and battery except the field wires should be No. 2.

Your committee was requested to make a recommendation for minimum dimensions and wishes to submit the dimensions that were approved last year and will state that they are not only the minimum, but are the maximum in height that can be used and meet "the third rail clearances" in an electrified zone and then the suspension construction should be such as not to hang too low. Roads whose car construction has the side sills lower than the Pullman Company's standard height may not be able to make their box so high or will have to do with less height in their door opening.

Respectfully submitted,

COMMITTEE ON TRAIN LIGHTING EQUIPMENT AND PRACTICE.

United States Civil Service Examination

The United States Civil Service Commission announces the following open competitive examination: hydro-electric engineer, associate hydro-electric engineer, assistant hydro-electric engineer.

Receipt of applications for the positions listed will close November 24. The examinations are to fill vacancies in the engineer department at large, Chattanoga, Tenn., at entrance salaries of $3,900 a year for hydro-electric engineer, $3,300 a year for associate hydro-electric engineer, and $2,400 to $3,000 a year for assistant hydro-electric engineer.

The duties of the engineer are, under the military officer in charge, to be responsible for the complete investigation of a proposed hydro-electric project, from the initial determination of the stream flow through the theoretical design and final estimate of the cost of the complete plant and transmission lines.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience, and fitness.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or custom house in any city.

East Station, Vienna, Austrian Federal Railways

Officers of the Railway Electrical Supply Manufacturers Association

R. E. S. M. A. Exhibit at A. R. E. E. Convention

The Exhibit is the Largest Ever Held by the Association and Includes 59 Manufacturers

THE exhibit presented by the Railway Electrical Supply Manufacturers Association at the 16th annual convention of the Association of Railway Electrical Engineers this year, as in each consecutive year, has exceeded all exhibits held previously. Meetings of the A. R. E. E. will be held in the grand ballroom, mezzanine floor, Hotel Sherman, Chicago, Illinois. The exhibit space is located on the same floor and the registration booth is centrally located for the convenience of members of both associations.

Exhibit Directory

The following is an alphabetical list of the manufacturers having exhibits at the convention and includes the exhibit space number (see diagram) with brief descriptions of the products shown and the names of the representatives present:

Adams & Westlake, Chicago, Ill.—Spaces No. 32 and 33.—Electric car lighting fixtures; electric ceiling fans; cast and sheet metal electric signal lamps for all classes of service; highway crossing flashing signals. Represented by A. S. Anderson, W. J. Piersen, H. G. Turney, W. G. Porter, E. H. Leisch, F. W. Foehringer, J. N. Black.

Ahlberg Bearing Company, Chicago, Ill.—Space No. 45.—Ahlberg ground bearings including a new line of single and double row bearings. Represented by W. C. Bender, H. E. Dunning, B. B. Clark.

Albert & J. M. Anderson Mfg. Co., Boston, Mass.—Space No. 59.—Automatic time switches; large capacity disconnecting switches and knife switches; plugs and receptacles of all capacity for battery charging; welding circuits and locomotive wiring. Represented by B. G. Durham.

Appleton Electric Company, Chicago, Ill.—Space No. 34.—Unilets; other conduit fittings; reelites; mogul reelites. The reelites are automatic take-up reels for handling electric cables. Represented by E. A. Hakanson, E. G. K. Anderson, A. S. Merrill, J. T. McHenry, A. F. Hakanson.

The Baker R & L Company, Cleveland, Ohio.—Space No. 12.—Locomotive type crane truck; elevating truck; tractor. Represented by W. F. Hebard, T. W. Barnes, F. N. Phelps, M. A. Watterson, H. B. Greig.

Benjamin Electric Mfg. Co., Chicago, Ill.—Space No. 40—Porcelain enameled reflectors; lighting panels; fibre hand portables; heavy duty railroad attachment plugs, etc., Represented by R. M. Prior, C. B. Harlow, W. J. Goodrich.

Bussman Mfg. Co., St. Louis, Mo.—Space No. 50.—Buss renewable fuses; Buss non-renewable fuses; Buss plug fuses; Buss open material; Buss auto fuses; Buss lights. Represented by Martin J. Wolf, Joseph C. Ingram, D. E. Spear, Jr., H. F. Williams.

Central Electric Company, Chicago, Ill.—Spaces No. 38 and 67.—Attalites; luminaires; maxolite reflectors; Ralco line of receptacles and plugs, Ralco line of locomotive devices; Maxocord; Mastercord; railway type fans; locomotive wire; Gibbs connectors; locomotive cab cords; V. R. marker plug; other devices especially designed for steam railroads. Represented by W. H. East, Geo. C. Jerome, W. P. McCann, Edw. L. Pollock, Jr., J. M. Lorenz, W. H. Glass, R. C. Close, W. E. Buckmaster.

Chicago Fuse Mfg. Co., Chicago, Ill.—Space No. 2B.—Improved Union renewable fuses; regular line of Union and Gem enclosed cartridge fuses of the non-renewable type both indicating and non-indicating; mica top plug fuses; sectional switch boxes; outlet boxes and covers. Represented by C. W. Beach, H. P. Collins, L. C. Noyes.

Crouse-Hinds Company, Syracuse, N. Y.—Spaces No. 19, 20 and 21.—Condulets; panelboards. Represented by C. H. Bissell, E. G. Smith, F. C. Smith, H. J. MacIntyre, C. L. Walker, D. A. Nesbitt, A. B. McChesney, R. H.

Goodwin, F. F. Skeel, Charles Dubsky, E. F. Granzow, W. W. Booth, N. E. Bigley, J. B. Wilmott, A. E. Vieau, F. W. Carlson.

Cutter Electrical & Mfg. Co., Philadelphia, Pa.—Space No. 61.—I-T-E circuit breakers; U-R-E Lites. Represented by O. M. Bercaw, I. S. Allen, David O. Stewart.

Daniel Woodhead Company, Chicago, Ill.—Space No. 4—Diehl fans; Wheeler reflectors; Ackerman tape; Candee tape; Protex holders; lamp guards; glassware for car lighting. Represented by Daniel Woodhead.

Economy Fuse & Mfg. Co., Chicago, Ill.—Space No. 24.—Economy renewable fuses and elements; Clearsite plug fuses; miscellaneous specialties. Represented by R. S. Smith.

Edison Storage Battery Company, Orange, N. J.—Space No. 3.—Edison steel alkaline storage batteries specially assembled and trayed for various branches of railroad service; exhibit board showing details of construction of the Edison battery together with cut-a-way cells of the various types. The exhibit features improvements made recently in the manufacture of this battery. Represented by A. M. Andersen, W. F. Bauer, R. C. Haley, J. L. Hays, D. C. Wilson, O. R. Hildebrant, U. W. McMillian, D. B. Mugan, O. A. Neidermeyer, A. S. Knox.

The Electric Controller & Mfg. Co., Cleveland, Ohio.—Space No. 68.—Type ZO oil immersed across-the-line push button operated starting switch for a.c. motors; E. C. & M. automatic starting compensators for squirrel cage motors; E. C. & M. altitude regulators and cushion tanks for the automatic control of water level of wayside pumping station tanks; No. 1 Youngstown safety limit stop for crane duty. The crane stop which is described in the New Devices Section of this issue is designed for use on small and moderate cranes where space mounting is restricted. Represented by E. C. Ryan, R. E. Bock, A. J. Walz.

Electric Service Supplies Company, Chicago, Ill.—Space No. 46.—Golden glow locomotive headlights; Golden glow floodlights; Keystone turbo generators; Keyston locomotive switches (electric); Keystone locomotive wiring fittings; portable lamp guards; coil winding and forming tools. The floodlights are of a new design in which the reflecting mirror is mounted on a rear door and gaskets are eliminated. They are described in the New Devices Section of this issue. Represented by C. J. Mayer, J. W. Porter, T. M. Childs, J. C. Bryan, B. D. Barger, E. G. McAllister, H. J. Graham.

The Electric Storage Battery Company, Chicago, Ill.—Spaces No. 14 and 15.—A new line of motor bus batteries; car control batteries; central station control batteries; series of oil paintings depicting Exide batteries in the oil fields. Represented by E. G. Beutter, W. C. Leingang, W. P. Roche, J. W. Tierney, E. H. Watkins, L. E. Lighton.

Erie Malleable Iron Company, Erie, Pa.—Space No. 54.—A complete line of Kondu fittings including a new type of threadless conduit fitting known as the Kondu-Box. The Kondu-Box is described in the New Devices Section of this issue. Represented by R. P. Dunmire.

Fairbanks, Morse & Company, Chicago, Ill.—Spaces No. 57 and 58.—Fairbanks, Morse ball bearing motor type HJ equipped with double cage wound rotor; type EH enclosed ventilated ball bearing motor for use in coaling stations, chemical plants and grain elevators; motors of both ball bearing and plain bearing design which have seen a long service. Represented by P. H. Gilleland, F. M. Condit, E. E. Pendray, H. E. Vogel, J. L. Jones, G. Howard, D. K. Lee, F. J. Lee, B. S. Spaulding, E. C. Golladay, G. W. Lewis, W. L. Nies.

Frank Adam Electric Company, St. Louis, Mo.—Spaces No. 83 and 84.—Panelboards and cabinets for passenger stations and freight houses, etc. The exhibit features a new unit type panelboard in which cut-out switches and cut-out switch cabinets can be inserted according to requirements in standard size cabinets. They are described in the New Device Section of this issue. Represented by D. Gillespie, E. Zinsmeyer.

The Gamewell Company, Newton Upper Falls, Mass.—Space No. 30.—Fire alarm signaling apparatus for protection of railroad properties and for supplementing activities of local fire brigades; watchmen's supervisory apparatus. Represented by Albert H. Cross, Frank N. Adams, Floyd H. Wright, George E. Morley.

General Electric Company, Schenectady, N. Y.—Spaces No. 39 and 66.—Motors; control apparatus; arc welding equipment; heating devices; flood lighting equipment; fused quartz. Among the control apparatus shown is a new type of relay known as the I. G. relay for use in limiting the power on distribution lines to a predetermined quantity. It is described in the New Devices Section of this issue. Represented by C. T. McLoughlin.

The Gould Storage Battery Company, Depew, N. Y.—Spaces No. 55 and 56.—Gould simplex electric car lighting equipment, showing various generators, regulators and suspensions; Gould simplex turbo generator for locomotive headlights; Gould storage battery as used in railroad car lighting. Represented by G. R. Berger, E. J. Blake, W. F. Bouche, M. R. Shedd, P. H. Simpson.

C. H. Hollup Corp., Chicago, Ill.—Space No. 29.—Coated iron welding electrodes, coated mild steel electrodes; coated medium steel electrodes; coated high carbon steel electrodes; coated high manganese steel electrodes; processed bare iron electrodes; processed bare mild steel electrodes; processed bronze electrodes; commercially pure iron oxy-acetylene welding rods; low carbon steel rods; Tobin bronze rod—manganese bronze rods; brazing wire; Tecor welding helmet; Tecor face shield; electrode holder; Tecor welding lenses; Tecor extra flexible welding cable. Represented by H. R. Pennington, K. R. Hare, Howard Hanna.

Industrial Controller Company, Chicago, Ill.—Spaces No. 27 and 28.—Class 2205, manually operated compensator; class 2406, alternating current motor circuit switch; class 8605, alternating current automatic compensator; class 8527, across-the-line type alternating current automatic starter; class 7107, direct current automatic starter; class 8547, primary resistance type starter; class 7110, direct current automatic starter; class 7120, direct current automatic starter. The primary resistance type starter is a new push button type starter which has a resistor supplied with three taps which can be adjusted to meet starting load conditions. It is described in the New Devices Section of this issue. Represented by John McC. Price, Earle J. Rooker, Ned Weller.

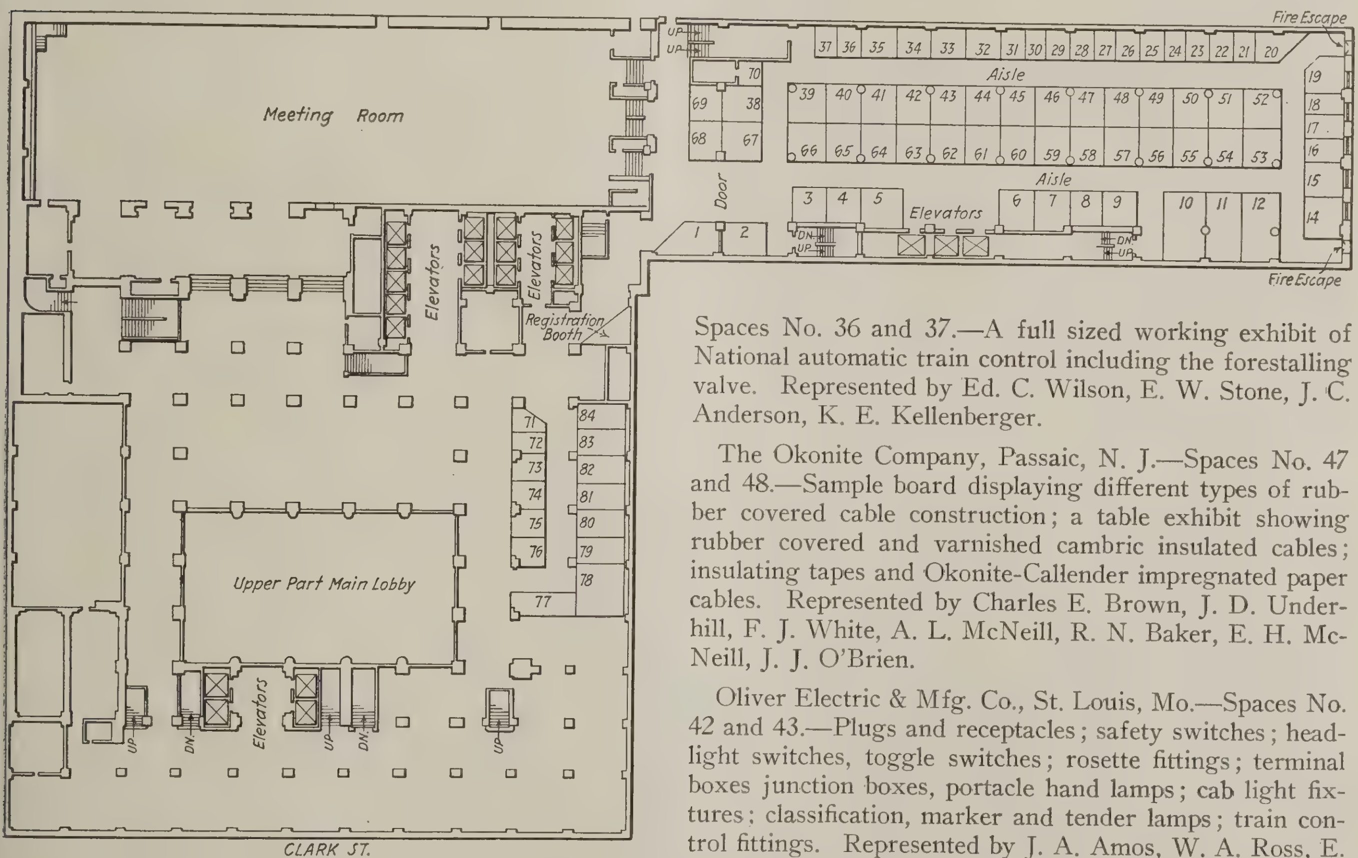
The Kerite Insulated Wire & Cable Company, Inc., New York, N. Y.—Space No. 65.—Wire and cable. Represented by B. L. Winchell, Jr., J. A. Renton, W. H. Fenley, C. E. Hieber, M. D. Cook, P. W. Miller, Azel Ames, C. A. Reeb, E. M. Branchfield.

Kulp-Theft Proof Lamp Company, Chicago, Ill.—Space No. 73.—Kulp theft proof lamps. Represented by Lester Kulp, E. H. Batchelder, Jr.

The Lincoln Electric Company, Cleveland, Ohio.—Space No. 49.—A new type of railroad arc welding set; Linc-weld polyphase motors. Represented by R. A. Davidson, C. R. York.

Loeffelholz Company, Milwaukee, Wis.—Space No. 35.—Gibb's train connectors and accessories; car lighting fixtures and appliances. Represented by L. R. Taylor, P. B. Bernhardt, G. B. Miller.

E. A. Lundy Company, Pittsburgh, Pa.—Space No. 11.—Line materials; high tension insulators, motors; transformers, rectifiers, relays, ampere-hour meters. Represented by E. A. Lundy, P. M. Etters, Preston Parish.



Location and Arrangement of Exhibit Booths

McGill Manufacturing Company, Valparaiso, Ind.—Space No. 31.—Wire lamp guards, portable lamp guards; soldering fluxes; Chatterton insulating compound; Levolier conduit box and fixture switch, Levolier pull sockets; Levolier porcelain wall brackets. Represented by H. G. Hafner, M. P. Thiel, Del Fabing, W. J. Doherty, Ernest Reed, V. R. Despard.

Mercury Mfg. Co., Chicago, Ill.—Space No. 69.—The Mercury line of electric industrial tractors for freight house, shop and passenger terminal use; the Mercury line of industrial trailers for railroad service in connection with the Mercury tractor; motion pictures of the Mercury equipment in actual use. The new Mercury type H internal gear drive tractor and improved type A-310 all-steel freight house and shop trailer are features of this exhibit. Represented by H. B. Clapp, Wm. H. Odiorne, C. W. Henkle.

Mutual Electric & Machine Company, Detroit, Mich.—Spaces No. 73 and 74.—Bull Dog safety switches for heavy duty service with luminized finish; Bull Dog safety Fusenters. The name Fusenters, is derived from the two words, fuse centers. It is a new product designed to take the place of the cut-out and fuse box and is described elsewhere in this issue. Represented by E. A. Printz, J. E. Schwarz.

National Lamp Works, Nela Park, Cleveland, Ohio.—Space No. 5.—Electric lamps of all kinds. Represented by L. C. Kent.

National Train Control Company, Sales Representative, The National Safety Appliance Company, Chicago, Ill.—Spaces No. 36 and 37.—A full sized working exhibit of National automatic train control including the forestalling valve. Represented by Ed. C. Wilson, E. W. Stone, J. C. Anderson, K. E. Kellenberger.

The Okonite Company, Passaic, N. J.—Spaces No. 47 and 48.—Sample board displaying different types of rubber covered cable construction; a table exhibit showing rubber covered and varnished cambric insulated cables; insulating tapes and Okonite-Callender impregnated paper cables. Represented by Charles E. Brown, J. D. Underhill, F. J. White, A. L. McNeill, R. N. Baker, E. H. McNeill, J. J. O'Brien.

Oliver Electric & Mfg. Co., St. Louis, Mo.—Spaces No. 42 and 43.—Plugs and receptacles; safety switches; headlight switches, toggle switches; rosette fittings; terminal boxes junction boxes, portacle hand lamps; cab light fixtures; classification, marker and tender lamps; train control fittings. Represented by J. A. Amos, W. A. Ross, E. H. Hagensick, William M. Graves, Jr., G. V. Wright.

Otis B. Duncan, Chicago, Ill.—Space No. 70.—Battery charging motor generator sets and control panels; commutator stones; commutator slotters; commutator blowers; commutator polishing compound; carbon and metallic brushes; carbon and metallic contacts. Represented by Otis B. Duncan, M. R. Berry, H. R. Bungay, Jr., L. C. Howard, H. P. F. Dering, B. F. Wallace, W. P. Lyon.

Pyle National Company, Chicago, Ill.—Spaces No. 62, 63 and 64.—A new Pyle-National aluminum alloy type 2375 floodlighting unit; the type E-3 four-pole wave form-wound turbo-generator for train control use; the

type M-7½KW turbo generator for train lighting; various types of headlight and locomotive lighting accessories. The floodlighting unit which is described in the New Devices Section of this issue is a departure from conventional projectors in that ventilation for cooling purposes is dispensed with. Represented by J. Will Johnson, Wm. Miller, C. P. McGinnis, L. H. Vilas, R. L. Kilker, P. S. Westcott, G. E. Haas, J. L. Reese, C. S. Geis, W. T. Bretherton, F. Kersten, R. S. Parsons, T. P. McGinnis.

Railway Electrical Engineer, New York, N. Y.—Space No. 1.—Books and Magazines. Represented by C. J. Corse, A. G. Oehler, R. S. Kenrick, R. Duysters.

Railway Purchases & Stores, Chicago, Ill.—Space No. 72.—Magazines. Represented by H. B. Kirkland, K. F. Sheeran, J. P. Murphy, Jr., Edward Wray.

Railway Utility Company, Chicago, Ill.—Space No. 17. —Utility electric heaters; Utility electric heat regulators; Utility ground detectors; Utility peak load reducers; Utility honeycomb ventilators. Represented by E. J. Magerstadt, E. G. Magerstadt, Wm. J. Pine, Wm. G. Hartwig, C. L. Haas, Albert Hirsch, R. R. Holden.

Safety Car Heating & Lighting Company, New Haven, Conn.—Spaces No. 6 and 7.—A complete line of equipment for the proper illumination of railway cars from batteries to fixtures as follows: The standard CLEF battery; three standard sizes of generators with the Universal suspension; type FF-10-R regulator; a new type of main switch; standard coach and postal car designs; new designs for dining cars, parlor cars and sleepers; a complete line of ceiling, bracket and exhaust fans. In addition to car lighting apparatus, type SOAF and MOG batteries for signal service and train control respectively, are being shown. The new type of automatic switch which operates at battery potential is described elsewhere in this issue. Represented by S. I. Hopkins, C. A. Chasey, C. W. T. Stuart, H. K. Williams, J. S. Henry, Geo. H. Scott, C. A. Pinyerd, G. D. Ladd, A. R. Hamilton, J. H. Rodger.

Simplex Wire & Cable Company, Boston, Mass.—Space No. 18.—Tirex portable cables; Tirex portable cords; Tirex welding cable; Tirex train line cable; Insulated wires and cables. Represented by H. R. Hixson, J. N. Macalister, W. F. Hruby, L. S. Jones.

SKF Industries, Inc., New York, N. Y.—Space No. 26. —Skayef self-aligning ball and roller bearings and Hess-Bright deep-groove radial bearings for car lighting generators and electrical equipment; models showing anti-friction qualities of Skayef and Hess-Bright ball bearings. Represented by W. L. Batt, J. B. Castino, H. E. Brunner, P. A. Carlson, H. A. Gumm.

Square D. Company, Detroit, Mich.—Spaces No. 81 and 82.—A line of Square D. safety switches; Wiggington voltage testers; power panels. The power panels are a new product of the Square D Company and are designed with individual insulating bases set into slots in a steel grid so that the fuse jaw space can be made to provide for either 30, 60 or 100 ampere fuses. They are described in the New Devices Section of this issue.

Standard Underground Cable Company, Pittsburgh, Pa. —Space No. 60.—Copper trolley and transmission wire; copper clad steel transmission wire and mechanical strand; high strength bronze trolley and transmission wire; weatherproof wire of all kinds; rubber insulated wires of all kinds; lead covered and armored cables for light and power service. Represented by R. E. Green, W. M. Rogers, H. K. Weld, J. H. Hohmann, E. H. Shutt.

Strom Ball Bearing Mfg. Co., Chicago, Ill.—Space No. 41.—Strom ball bearings for railway applications; two moving exhibits illustrating low-friction resistance of Strom ball bearings. Strom Ball Bearings of a new type, described in the New Devices Section of this issue, are being shown. Represented by George A. Strom, Marvin E. Monk, Harry N. Parsons, Miss Cora C. Smith, C. V. Johnson, H. R. Higgins.

Sunbeam Electric Mfg. Co., Evansville, Ind.—Space No. 9.—Sunbeam turbo-generators for headlights; Sunbeam turbo-generators for train control; Sunbeam airtight headlights; Sunbeam glass reflector headlights; headlight accessories. Represented by W. T. Manogue, C. W. Marshall, C. E. Kinnaw, J. Henry Schroeder.

The Thompson Electric Company, Cleveland, Ohio.—Space No. 2A.—Lamp maintenance equipment comprising Thompson safety lowering switches and disconnecting hangers and accessories. Represented by A. J. Thompson.

Trumbull Electric Mfg. Co., Plainville, Conn.—Space No. 8.—Trumbull safety enclosed electric switches. Represented by M. L. Spaulding.

U. S. Light & Heat Corp., Niagara Falls, N. Y.—Space No. 44.—USL electric arc welder; USL car lighting storage batteries; USL starting and lighting storage batteries for buses. The welding generator and the car lighting batteries are improved devices. The batteries are now made by the "Faure" process and the generators are interpole machines with improved inherent stabilization. They are described in the New Devices Section of this issue. Represented by W. L. Bliss, E. Bauer, J. L. Fosnight, R. J. Stanton, A. W. Donop, R. R. Desmond, C. H. Sullivan, W. W. Halsey, G. E. Anderson.

United States Rubber Company, New York, N. Y.—Space No. 51.—Hard rubber jars; covers and accessories which are used in connection with electric train lighting. Represented by L. S. Hungerford, Jr., George Haines, J. F. McDonnell.

Victor Balata & Textile Belting Co., Easton, Pa.—Space No. 22.—Karbelt, an improved car lighting belt for car lighting purposes; improved belt fasteners for car lighting belt. Represented by Edwin Vollrath, L. J. Walters.

Weber Brothers Metal Works, Chicago, Ill.—Space No. 71.—The improved Rochlitz automatic water still. Prior to 1922 this product was sold under the name of the W. M. Lalor Company, and since it was taken over by the Weber Brothers Metal Works, Mr. Lalor has retained his connection in the sale of the apparatus. Represented by W. M. Lalor.

Westburg Engineering Company, Chicago, Ill.—Western selling agents for Weston Electrical Instrument Corp., Newark, N. J.—Space No. 16.—Indicating electrical measuring instruments; including voltmeters, ammeters, magneto speed indicators for use in connection with train control work; phase angle meters. The magneto speed indicator was recently developed for car and locomotive use especially in connection with automatic train control. It is described in the New Devices Section of this issue.

Represented by Paul A. Westburg, Leon C. Herrmann, Alvin Thielke, James F. Inman, Kline Gray.

Western Electric Company, Inc., Chicago, Ill.—Space No. 10.—

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. —Spaces No. 52 and 53.—Electric equipment for turntable; headlighter set; lightning arrester demonstration equipment; instruments; floodlight unit; lamps; reflectors and sockets. The floodlighting unit and the reflectors and sockets are newly developed products. The floodlight is a cast iron unit so designed that the heat generated by the lamp is dissipated by radiation and ventilation is unnecessary. Reflectors have been designed for railroad use and are made with cast iron socket hoods and one piece porcelaid sockets with lamp grips. These products are described in the New Devices Section of this issue. Represented by W. W. Reddie, A. J. Manson, J. S. Gilmore, F. M. Hunter, C. W. Regester, R. H. Kilner, G. T. Keech, L. A. Spangler, A. P. Schrader, A. M. Candy, C. F. King, Chas. Kerr, R. J. Ross.

Willard Storage Battery Company, Cleveland, Ohio.—Space No. 25.—Train lighting battery with Willard thread rubber insulation; train control batteries; gasoline rail car-batteries; bus batteries; radio batteries; signal batteries. Represented by Louis Sears, C. T. Klug, C. E. Murray, M. J. Brennan.

The Real Obstacle

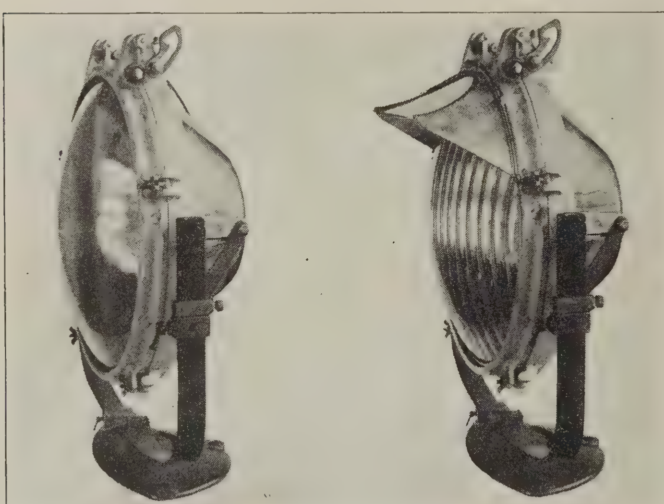
Like other weazened, awkward runts,
I dodged this golf thing months and months,
Until one sunny day:
I was coaxed to borrow clubs
And with three other vernal dubs—
I sallied forth to play.
They'd mowed a "fairway" from each tee,
But they didn't cut that swath for me:
When I do my strong-arm stuff:
My ball ignores with high disdain
Such routes, and like an aeroplane—
It sails out o'er "the rough."
In deep ravines and under trees
Or where the weeds grow to your knees—
That's where my "pill" would drop;
Through shimmies, bounces, hops and rolls
It hunted muck and gopher holes
And then it had to stop.
And when at last I reached the green
My Jinx was feelin' low and mean
And filled my soul with woe:
Where some "putt" once and hit the pin—
The only way I could get in
Was to shove it with a hoe.
So far I've played just forty holes;
In slices, bunts, topped balls and rolls
With about three hundred clouts:
They tell me that in thirty years
A guy can tame these little spheres,
But now I have me doubts.
My own impressions must define
Golf as a sort of pantomime
Dressed up in woolen socks;
If on the links you say four words,
To these serious-minded birds,
You're called a chatter box.
I sort o' like to clout the pill
And sail it high above the hill;
I need to walk and walk,
But before the urge I'll really heed
The game must just one point concede—
They gotta let me talk.

Electro-Motive Company Gas-Electric Car for Local Service, Mexico City, Includes Baggage Room, Post Office and First and Second Class Passenger Compartments—S. M. Vauclain in Driver's Seat

NEW DEVICES

New Footlight Eliminates Ventilation Difficulties

The importance of adequate floodlighting of railroad yards and terminals is becoming generally recognized because of the greater safety afforded to employees and the improvement effected in night work and property protection. However, to secure proper illumination efficiency



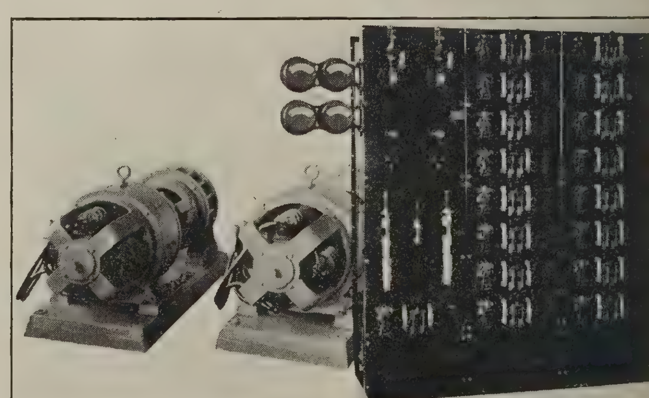
Left Projector with 23-in. Plain Cover Glass
Right—Same Type Equipped with 23-in. Rectangular Divergence Lens and a Visor

from floodlighting projectors it is essential that the reflectors be kept clean, a difficult and expensive maintenance item with ventilated projectors.

As a departure from conventional floodlight projector design the new Type No. 2375 projector recently introduced by the Pyle-National Co., Chicago, dispenses entirely with the necessity of ventilation for cooling purposes. The provision of sufficient radiating surface insures safe interior temperatures for the glass reflector and lamp when using 1,000 and 1,500-watt lamps. Machined surfaces at the door joint and a soft lead packing ring are noteworthy features which exclude effectively dust, moisture, gas and insects from within the case. To prevent corrosion from locomotive gases as well as the ordinary elements, the case of the projector is of cast aluminum alloy, with a drawn aluminum back, while the fittings and other small parts are of either aluminum or bronze. Focusing adjustments are made from the outside of the case, the provision of locking devices on the mounting base and trunnions preventing any accidental change in adjustment by the maintainer. The reflector, which is 23 in. in diameter, can be furnished in either the "Non-glare" or crystal glass type, while the lens may be plain or of the rectangular divergence type if a wide angle of light dispersion is desired. A visor with an enamelled reflecting surface, as shown in one of the views, can be furnished for cases where the projector is mounted on a high pole and operating conditions require light close to the pole.

Motor Generator Charging Set and Switchboard

For places where only alternating current is available and it is desired to supply direct current for charging storage battery trucks, the Electric Products Company of Cleveland, Ohio, has developed a motor-generator set and switchboard to meet the requirements. The system of



Truck Battery Charging Equipment

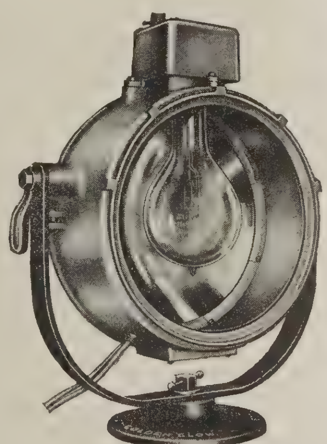
charging employed, is known as the modified constant potential system in which a constant voltage is maintained at the generator through various changes of load. The motor generator sets are ball-bearing throughout, insuring high efficiency and ease in replacing bearings. Through a liberal use of material a very flat voltage characteristic is provided from no load to full load.

The generator frames are of rolled steel and electrically welded. The motor is connected to the generator through a flexible coupling which relieves the bearings of any strain.

The distributing switchboard is of the standard sectional type, providing main overload and reverse current protection in each generator circuit, with field regulation and fused line switch for parallel operation of the two motor generators. The 17 circuits each controlling one battery are alike, comprising battery cut-off circuit breakers actuated by an ampere-hour meter mounted on the truck itself, fused battery switch and spring return type of meter reading switch.

Floodlighting Projector

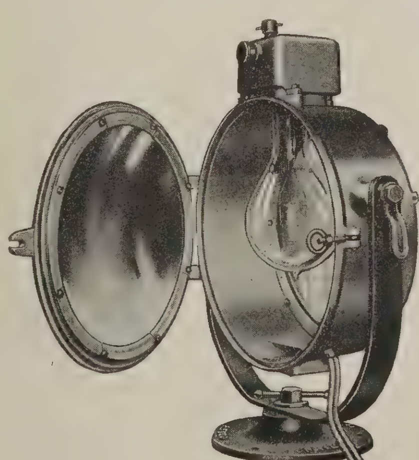
The Electric Service Supplies Co., Philadelphai, has recently placed on the market a new type of Golden Glow flood lighting projector (known as type FLA-1419) for railroad yard floodlighting or other similar service. This new unit has been designed to provide a simple and rugged housing, made of cast aluminum alloy in which is mounted a standard 14-inch reflector.



General View of Projector

The design of the body of this new projector is unique in that the glass reflector is mounted in the door which opens from the back of the case, thus providing easy access for the renewal of lamps and for cleaning the reflectors. The door closure is a series of baffles with machined surface fit and provides a very simple, substantial and effective weather tight closure, without gaskets.

This new unit provides ample ventilation through liberally designed ventilating apertures at the bottom and the top of the body. An easy and simple focusing mechanism is enclosed in the top ventilating cap, which permits focusing of the lamp entirely from the outside and without tools.



View Showing Rear Door Open

The body of the projector is mounted on trunnions in a yoke of ⅜ x 2 inch steel bar stock which may be rotated in the heavy cast iron base.

The curved front glass of the projector is of special heat resisting pressed glass, approximately ¼ inch thick, which practically eliminates breakage.

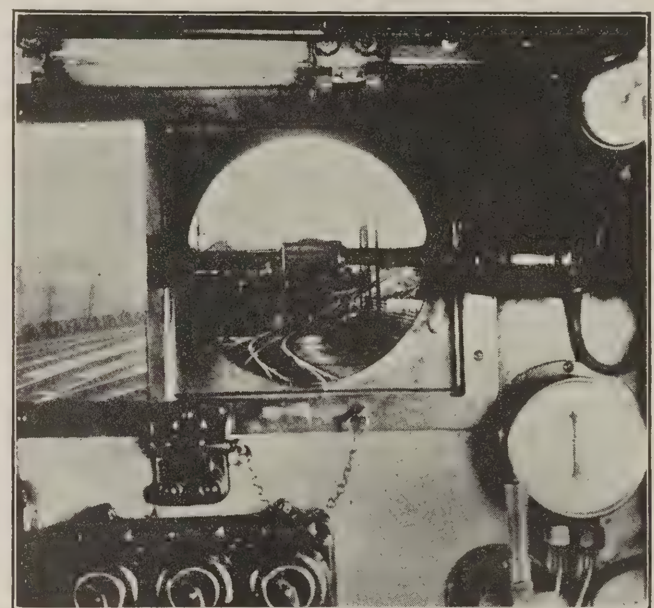
These new floodlights when fitted with a 1000 watt, 115 volt PS-52 standard multiple burning lamp may be used successfully with maximum ranges of 3000 to 3500 feet when mounted on towers of from 70 to 90 feet in height. Golden Glow light has a soft, non-glaring character and is very penetrating.

A large number of these projectors have recently been installed in the Clifton Forge classification yard of the Chesapeake and Ohio R. R. Co.

Clear View Screens

Chas. Cory & Son, Inc., New York, N. Y., has accepted the exclusive manufacturing and selling rights of Kent's Clear View Screens for the United States and Canada.

Clear view screens consist of a polished glass disc rotated on a central bearing by an electric motor at such a speed that rain, spray and snow are instantly dispersed. Complete transparency is maintained in all weather conditions.



Clear View Screen Installed in Cab of an Electric Locomotive

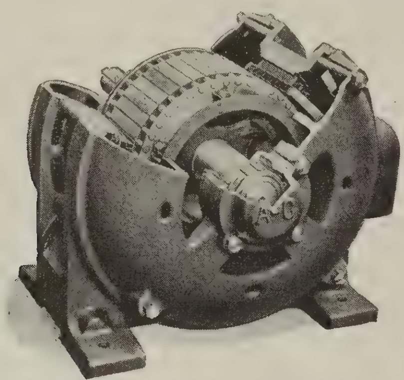
The complete instrument, supplied as a mechanical unit consisting of disc, frame, motor and motor bracket, is mounted in a polished teak frame. A metal frame hinges inward to allow access to the front of the disc.

Roller Bearing Type Motor

After two years of experimental and development work, the Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin, has placed on the market a complete line of twenty-five and sixty cycle squirrel cage and slip ring induction motors equipped with Timken Tapered Roller Bearings. The Timken bearing was selected only after very careful consideration of the many questions of design and operation. After designs of bearings and mountings had been made, a number of motors of various sizes were built and tested under actual operating conditions of belt, gear, chain and coupled drives, a sufficient length of time to insure satisfactory service. The Timken bearing has been used because of its ability to withstand continued heavy radial

and thrust loads without undue heating or appreciable wear. It is particularly suited to heavy service and will operate satisfactorily at the high speeds found in the general purpose induction motor. Because of the rolling action of the bearing, there is practically no wear so that the factory adjusted air gap is maintained indefinitely, eliminating any possibility of the rotor striking the stator.

The important question of lubrication is greatly simplified, as grease is used requiring very infrequent attention on the part of the operator. The bearings have grease tight enclosures effectively excluding dirt or abrasive matter that might cause undue wear of the bearings. The



Sectional View Type "AR" Roller Bearing Motor

mounting of the bearings is very simple, being only a light press fit for both the cone and cup, and not requiring the use of a lock nut or other means of holding the races in place. This also facilitates the removal of the bearings whenever necessary.

In addition to the bearings, special attention has been given to many other features of design of this line of motors. The frame is made of steel with feet cast integral, to withstand shocks. The coils are thoroughly insulated and baked in a water-proof varnish. The openings in the housings and frames for ventilation are so placed in vertical planes, that falling objects cannot enter the motor.

This motor can now be obtained in all ratings, twenty-five and sixty cycle, 200 hp. and smaller.

Cord Strengthening Device

A strengthening device, known as the "Arro-Grip" used in connection with reinforced cords for drop lights and extensions, has been placed on the market by the Arrow Electric Company of Hartford, Conn. The device con-

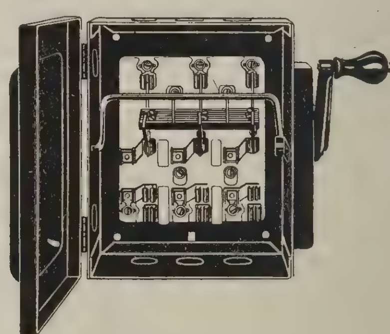
Various Wiring Devices Showing the Application of the "Arro-Grip"

sists of a metal clamp which is held tightly around the cord near the fitting by means of machine screws. A part of the device is secured to the fitting and in this way the strain is entirely removed from the binding posts of the attachment plugs or sockets as the case may be. The grip is particularly useful in shops in connection with extension cords where rough handling by yanking out attachment plugs by the cord is frequently practiced. The grip is obtainable only on Arrow devices.

Two and Three Pole Starting Switches

The Wadsworth Electric Manufacturing Company, Covington, Ky., has recently placed on the market a new type of motor starting switch known as No. 3033. The new switch is rated at 250 volts and is designed for double throw as may be seen from the illustration. If necessary, the switch can be thrown from the starting position to the neutral position without going into the running position. There are six connections to make on the three pole starter—three to the line and three to the load.

Number 3032 is the same as 3033 except that it is a two pole switch instead of a three. Although the space

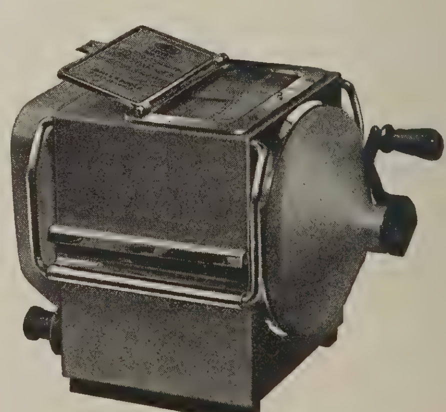


Three Pole Switch

required for mounting is small, the inside dimensions being 7½ in. by 9 in. and 4 in. deep, there is ample wiring space. Adequate knockouts are provided at top, bottom and left side of the cabinet. A single spring supplies the necessary tension and this is housed on the right side of the cabinet so as to be protected from the live parts of the switch. The switch is finished with baked, black enamel.

"Meg" Insulation Tester

Certain systems of automatic train control require a rather high standard of electrical insulation—particularly



"Meg" Insulation Tester

the wiring on locomotives as well as electrical equipment along the roadway. For making tests in this connection the instrument known as the "Meg" Insulation Tester has

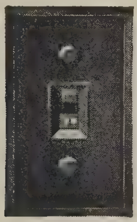
proved well suited for the purpose. With this device insulation resistance up to 100 megohms can be tested quickly and easily, and with almost no chance for error.

The "Meg" consists essentially of a 500 volt d.c. hand generator which supplies potential for the test, and a direct reading ohmmeter which indicates the result. There are only two binding posts, one of which is attached to "ground" and the other to the wire or apparatus under test. Upon turning the crank at approximately 120 r.p.m. the result is indicated at once by a pointer on the scale. One of the chief additional advantages of the "Meg" is its light weight—this being approximately 6¾ lb.

The "Meg" is supplied by James G. Biddle, 1211 Arch Street, Philadelphia and is the most recent addition by that firm to their well known line of Megger Testing Sets. Compared with the so-called "Megger" the "Meg" is much lighter in weight, smaller in size and lower in price.

Bakelite Wiring Devices

Bakelite switch plates are being introduced by the Connecticut Electric & Manufacturing Company at Bridgeport, under the name of "dead front" Bakelite plates. These plates are intended for use with the toggle switches manufactured by the same company. The illustration at



Bakelite Front and Toggle Switch

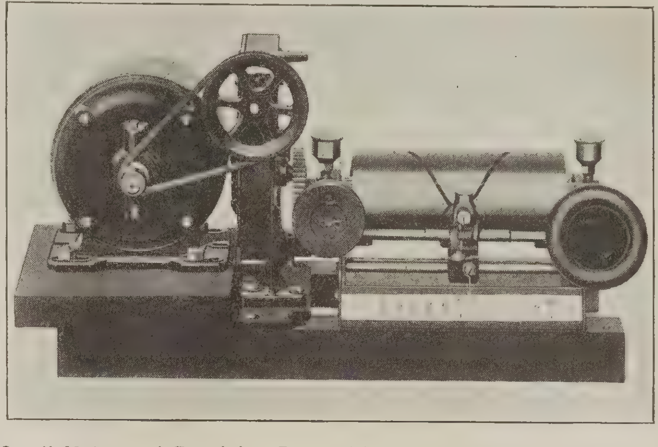
Bakelite Front on Convenience Outlet

the left shows a bakelite switch plate with a toggle switch inserted.

The same idea is also used in connection with combination outlets as may be seen at the figure on the right. The plates are ordinarily of a rich brown egg-shell finish, although combination plates and special finishes can be furnished when required.

An Adjustable Speed Polyphase Motor

An adjustable speed polyphase motor has been recently developed by the Louis Allis Company of Milwaukee. Broadly speaking, the applications of such a motor are divisible into two distinct classes—first, those applications which can only be met by continuously constant speeds and second, those applications which require only that constant speed within a given interval is material, provided a certain average constant speed for that interval is maintained. To meet the second classification, the motor here described was brought out. By means of brushes which are connected to the windings of the motor and which are in sliding contact with a revolving cylinder an average constant speed is effected. The cylinder is made to revolve at from one to two revolutions per minute by means of a small fractional horsepower motor. Part of the cylinder is permanently attached with a high speed winding and part to the low, and the adjustable brush is furnished which can be moved backward and forward on a rod. In this way, the motor can be made to operate part of the time, say for half a minute, at the high speed rate and then for half a minute at the low speed rate,

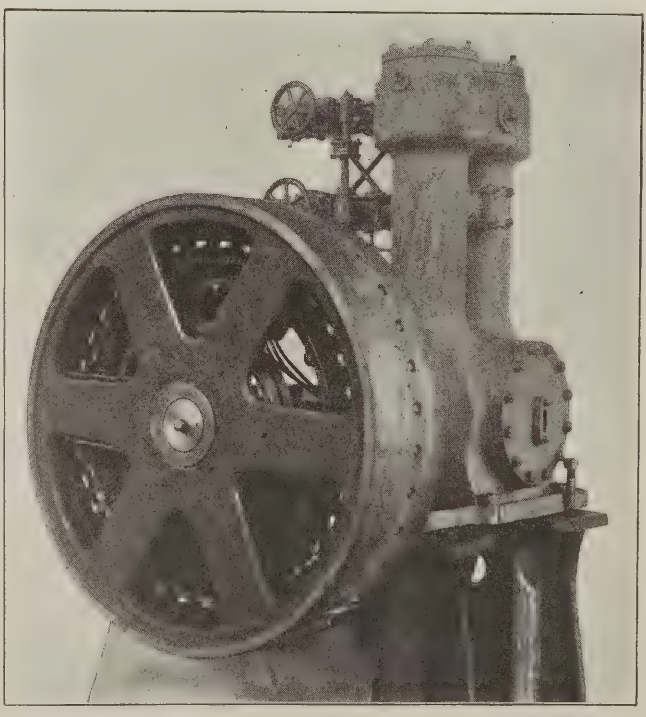


Small Motor and Revolving Drum Which Regulates the Speed of a Large Polyphase Motor

from which it will be seen that the average speed per minute is the average of the two rates of speed. In this way any average speed within the range of the motor may be obtained.

A Fly Wheel Synchronous Motor

A fly wheel type of synchronous motor in which the fields and the rotor revolve outside the stator, has been placed on the market by the Ideal Electric & Manufacturing Company of Mansfield, Ohio. These overhung synchronous motors are particularly adapted for air and ammonia compressors. They are limited in horsepower rating from 15 to 100 hp. and speeds from 164 to 400



Fly Wheel Type Synchronous Motor Driving Compressor

r.p.m. The machines may also be used as alternating current generators to be driven by small steam engines, oil engines or gas engines.

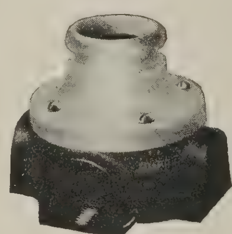
In several cases where it was desirable to obtain a large fly wheel effect, it was found practical to build a double rim wheel, mounting the alternator on the inside of the inner rim, and using the outside rim for the fly wheel effect required.

As all of the vital parts are inside, it is claimed that this rotor construction does not require such careful handling as the old type and the rotor may be rolled on the floor without in any way damaging the poles or squirrel cage windings. As constructed, the new machines form a part of the compressor unit. It is shipped ready to run and no motor foundation or erecting work is necessary.

Two Heavy Fittings

The Adapti Company, Cleveland, Ohio, has recently increased its line of wiring devices with a number of new fittings known as the 600 line. These fittings are small but strong and are particularly suitable for railroad work in such places as subway and tunnel construction. The 600 and 601 fittings have two holes tapped, one with a

Type No. 600 with Bryant Composition Receptacle



Type No. 610 with Bryant Porcelain Receptacle

removable plug inserted. Numbers 610 and 611 have four holes tapped, three of these being equipped with removable plugs.

The fittings are approximately 2¾-in. in diameter and 1½-in. deep and are supported by four screws. Any cover listed for use with the standard line of Adapti boxes, base 500, is available for use with these fittings and can be finished with four supporting screw holes instead of two if desired.

New Tool for Car Repair

A new type of portable electric cranes of the battery driven type, built by The Elwell-Parker Electric Co., Cleveland, is now offered the car repair department. This unit running on standard gage track, will pick up deliveries at shop or in yard and deliver either alongside or actually place the piece on the car ready for bolting or riveting. It is serving as a dismantler of cars as well as an assembler and gathers scrap or waste material which it places on pile or in scrap car. It will push loaded hand cars or roll axles to spot where installed.

The crane boom is of the telescopic type and of such floor type crane. Special heavy steel axles with good clearances beneath, fitting the standard gage rail track, are employed. The wheel base of the crane is practically the same as most hand pushed cars and they use the same turntables as the latter.

The crane boom is of the telescopic type and of such length and readily adjustable so as to reach over the middle of a car on the adjacent track. The upper end of the boom is so curved that it clears the side of a gondola car eleven feet above the rail. The operator retains his driving position on tructor pedals when hoisting, raising or lowering boom or when slewing boom through 180 degrees from right to left track. All operations are by electric motor but the slewing may be effected by either hand or motor mechanism as specified.

The outfit weighs approximately 7000 pounds when fully equipped. It handles any load up to 3000 pounds which brings within its range 90 per cent of the parts handled in car repair work. A crane on each third track serving cars

Portable Battery Driven Electric Crane

on either side can do practically all the lifting and material handling thus saving the use of the heavy locomotive type crane for work better suited to its capacity. It is built to work on the hottest or coldest days. The standard Elwell-Parker safety controls of power and brake are used throughout on this new equipment.

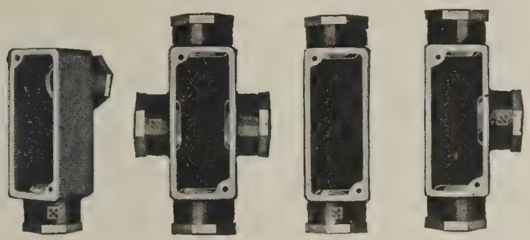
A Novel Line of Conduit Fittings

The Erie Malleable Iron Company, of Erie, Pa., announces a new type of threadless conduit fitting, trade named Kondu-Box, for which great economy of installation is claimed. A complete line of these fittings, both round and oblong, are to be manufactured.

The distinctive merit of the Kondu-Box fitting is the fact that it grips the conduit securely without threading the conduit by means of a tapered bushing, thus eliminating the costly operation of thread cutting and the labor of screwing the conduit into place.

A case-hardened bushing, having tapered threads for a lock nut and a tapered base, is the basic feature of the design. This bushing takes a parallel grip on the conduit, due to its tapered thread being balanced by a slight taper

on the interior of the body in which it seats; the grip is reinforced, and a perfect running ground secured at the same time, by means of sharp ridges or rings on the interior of the bushing. These ridges are forced through the enamel and cut into the conduit when the lock nut is tightened. A slot in the bushing is so arranged as to have a bank brake action which serves as an effectual lock against loosening by vibration and requires a minimum amount of effort to grip the conduit properly. Fittings slip into position on the line without necessity of screwing up the conduit. Any sort of bend may be made in the conduit and any desired type of fitting inserted at any point

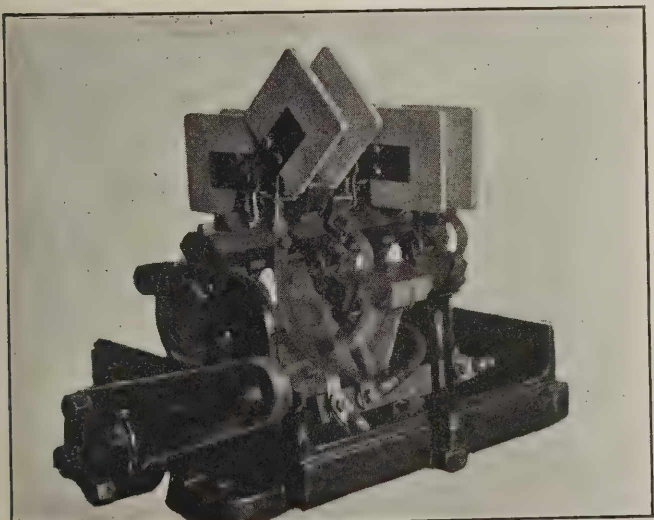


An Assortment of Kondu-Box Fittings

without recourse to unions or running threads. The Kondu-Box is made of certified malleable iron to give it strength and immunity from breakage. The Kondu-Box line, the manufacturer states, will be complete for all requirements. This will include a complete assortment of round and square boxes for various sizes of conduit, as well as the necessary threadless couplings, adapter bushings for standard steel knockout boxes, adapters for connectors to flexible conduit, etc. The above enables the installer to complete a threadless job with no other tools than a wrench, a hacksaw and a reamer.

Safety Limit Stop

A new addition to the devices manufactured by the Electric Controller & Manufacturing Company of Cleveland, Ohio, is the Youngstown Safety Limit Stop for



Inside View of the New Safety Limit Stop

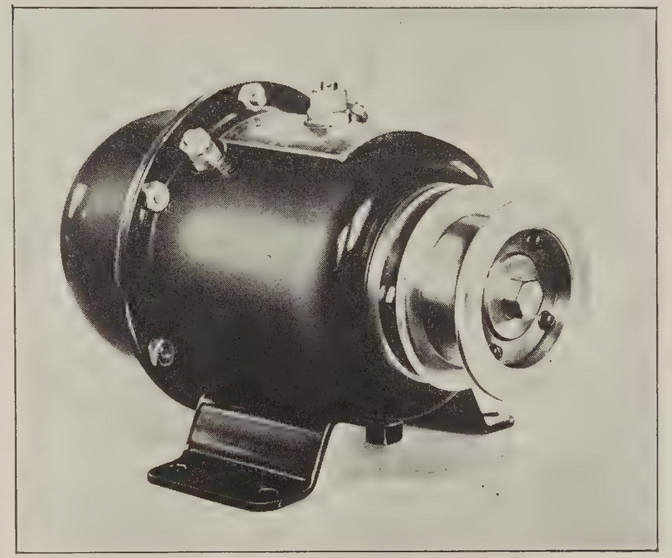
direct current motors. Although the company has been making stops for a number of years, the recent addition, which is known as No. 1, is strictly a new design. It is of compact dimensions for use on small and moderate sized cranes where space mounting is restricted. It uses a single operating weight. The stop has a powerful spring operating quick make and break operating mechanism with all parts mounted within the frame and protected by a sheet steel cover.

The automatic braking action is not dependent upon the position of the controller handle and the same quick stop will be had regardless of whether the operator leaves the controller on or throws it to the off position.

The Youngstown Safety Limit Stop is suitable for use in connection with direct current motors up to and including 90 hp., 115 volts and 150 hp., 230 or 550 volts.

Speed Indicator for Train Control

The Weston Electrical Instrument Company of Newark, N. J., has recently adapted its speed indicator to car and locomotive use, especially in connection with automatic train control system. The photograph shows the magneto which is a part of this device. When used in connection with railroads, this magneto is provided with a special housing. The indicating part of the railway



Magneto Unit Used in Connection with Speed Indicator

speed indicator consists of a voltmeter calibrated to read in miles per hour.

On account of the varying diameter of truck wheels upon which the magneto may be mounted, it is necessary to provide some means for making adjustments so that the indicator will read correctly. This is accomplished by the use of an adjustable resistance unit or rheostat which is housed in a water tight box. This unit consists of a nest of resistance wire spools mounted on a bakelite base. Each spool terminal is stamped with a diameter in inches of the truck wheel with which that spool is to be used. The resistances are made in two standard ranges, one covering wheel diameters from 27 in. to 36 in. and the other from 35 in. to 45 in.

Railroad Type Reflectors and Sockets

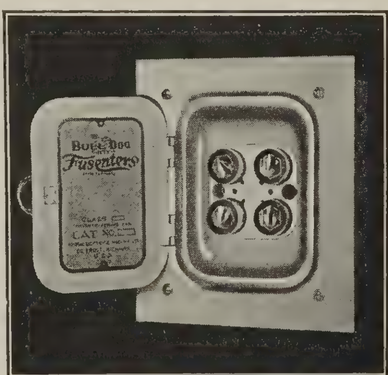
The new Westinghouse heavy duty railroad type sockets and reflectors have been designed to meet the exacting requirements of railroad use and other installations

where the lighting equipment is subjected to severe operating service. RLM reflectors, standard bowl reflectors, standard angle reflectors and shallow dome reflectors are all furnished with threaded copper heels which engage in the threads of the railroad type cast-iron socket hood.

The sockets are of one piece porcelain, front connected, with lamp grips to prevent the lamp from loosening by vibration. All socket metal parts and screws are brass. All the features of the Westinghouse reflector-sockets are found in these railroad type sockets. The porcelain is housed by a galvanized cast-iron hood painted green. This hood is tapped at the top to receive ½-inch conduit and has a machine thread at the bottom to fit the reflector.

Luminized Fuse Cabinet

The Mutual Electric & Machine Company, Detroit, Mich., has recently placed on the market a small compact fuse cabinet, under the name of "Bull Dog" Safety Fusenters. As with other products of that company, the front of the Fusenters are made with an aluminum finish. They are intended to replace unsightly cut-out and fuse boxes. Because they can be centrally located, the length of the circuit wiring is materially reduced and wiring costs are lower. The Fusenters can be readily painted any color desired to harmonize with the surroundings, as a luminized finish is a base coat for any paint.



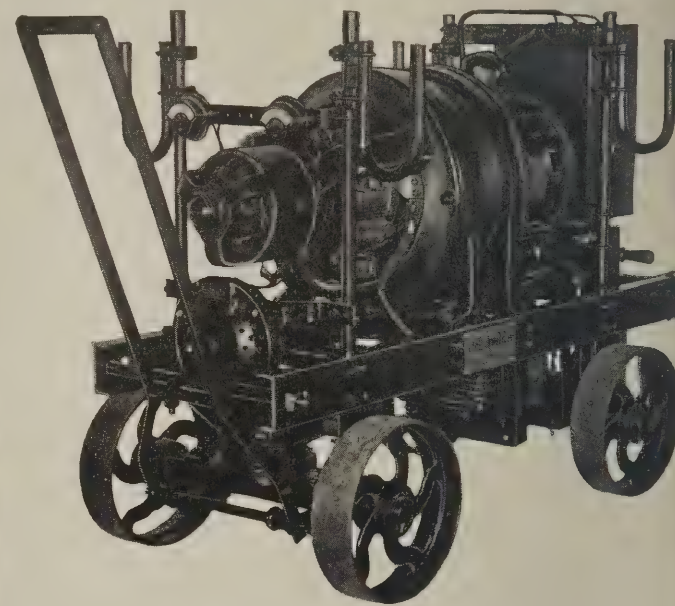
Fusenter with Luminized Front

Interpoles Added to Welding Generator

The USL welding generator, manufactured by the U. S. Light & Heat Corporation in 200 and 300 ampere capacities is a four-pole self- and separately-excited shunt machine with an all laminated magnetic structure. This type of construction permits a rapid change of magnetism so that the arc will respond quickly to the varying conditions and adjust itself to any demand. Each main pole is provided with two shunt field windings. One set of field coils receives current from a small exciter generator, while the other set is connected to the brushes of the welding generator. The effective flux is produced by the combined action of the self- and separately-excited fields.

In order to provide perfect commutation under severe service conditions the USL 300 ampere arc welder is equipped with four commutating poles. With the addition of these commutating poles perfectly black commutation at any load up to 350 amperes is assured. Maintenance cost and brush wear are therefore a minimum.

The feature of good commutation on machines with variable and fluctuating loads is of utmost importance in view of the fact that instantaneous inherent regulation is most effective on machines with smooth commutators. Another advantage gained through interpoles is the slight compounding action of the interpole flux which results in a steadier and more tenacious arc. This feature will be appreciated by all engineers experienced in the art and application of arc welding. The last advantage is the inherent arc current stabilizing action of the interpole windings. As the interpole windings, being connected in series, always carry the full welding current, a very pronounced internal reactance is set up and to such an extent that under certain conditions the usual external stabilizer may be eliminated. This latter advantage is of decided importance in so far as a reduction in size or the entire elimination of the external reactance results in a higher over-all efficiency of the welding equipment.



U S L Portable Welding Outfit

Improved Flood-Lighting Projectors

The Westinghouse improved flood-lighting projectors are built to withstand hard usage. They are mounted on cast iron bases by means of a steel trunnion or bow. The swivel base furnished with the small sized projector, and the quadrant swivel base furnished with the two larger sized projectors afford universal adjustment. All projectors are finished in hard black glossy finish which is oil, water and acid proof.

The new line of Westinghouse Flood-Lighting Projectors is made of three sizes. The smaller size accommodates 100-200 watt PS-25 and PS-30, the medium size 300-500 watt PS-35 and PS-40 and the large size 750-1000 watt PS-52, standard gas filled lamps. For a horizontal beam the lamps burn in a vertical position, base up. For other than horizontal beam, lamps burning in any position should be used. It is possible to focus the lamps to a high degree of accuracy by adjusting the three set screws which are placed in accessible positions on the top of the projector.

The large and medium sized projectors are furnished with either narrow beam or wide angle reflectors. The small projector is furnished with a narrow beam reflector only. These reflectors are of metal, spun over metal forms assuring a high degree of accuracy and beam control. The reflecting surface is highly polished and is designed to

give maximum service during the life of the projector.

The projector bodies are made of cast iron. A cast iron door frame gasketed to exclude moisture and dust from the interior of the unit supports the glass front. In the two larger sized projectors the door is hinged and is equipped with swivel bolts and handles for tightening. The door of the smaller sized projector is held by three swivel bolts with wing nuts.

Where the lighter weight projectors are required, flood-lights with aluminum bodies and door frames can be furnished at a moderate increase in cost. By casting these bodies of aluminum a very substantial reduction in the net weight is effected and the price is increased approximately 25 per cent.

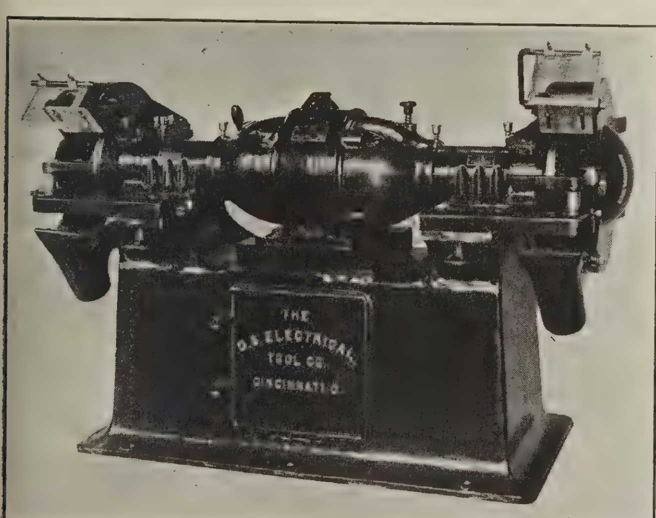
The medium and large sized projectors are equipped with clear convex heat resisting glass fronts which will withstand the severe strains due to expansion and contraction during rain or snow storms. Owing to the low temperature developed in the small size projector, heat resisting glass is unnecessary and therefore is not used. There projectors are equipped with double strength glass fronts.

These projectors are designed so that the heat generated by the lamp is dissipated by radiation and ventilation is unnecessary. They are as nearly dust proof as possible, assuring a long life to the reflecting surface and minimum maintenance during operation.

The large and medium sized flood-lights can be furnished with convex heat resisting spread lenses when greater than thirty degree beam divergence is required.

Heavy Duty Constant Speed Grinder

A heavy duty adjustable speed grinder, suitable for either alternating or direct current, has recently been placed on the market by the United States Electrical Tool Company of Cincinnati, Ohio. These grinders are so designed that the adjustment of the guards of the wheel will automatically regulate the speed of the motor so that the peripheral speed of the wheels is constant regardless of the wheel diameter. When used on direct current, constant peripheral speed can be obtained regardless of the wheel size.



Constant Speed Grinder for Use with Alternating or Direct Current Motors

On alternating current, starting with a 24 in. wheel at 900 revolutions per minute, a periphery of approximately 5500 ft. is obtained. The wheel can be used until it is worn to 18 in. at which time the next speed of 1200 r.p.m. will automatically cut in by moving a hand lever which will then bring the periphery up to approximately 5500 ft. Another change in speed occurs when the wheel is worn to 12 in. which increases the speed of the motor to 1800 r.p.m. which will then again bring the speed up to approximately 5500 ft. The alternating current motor on these machines is a three speed motor namely: 900, 1200 and 1800 r.p.m.

The New Edison Nite Box

This Edison Storage Battery "Nite Box" has been designed to meet several needs, but particularly for use as Head Light and Extension Inspection Lamp for motor driven or hand propelled inspection cars used on railroads. It is also a desirable adjunct as an emergency light for passenger cars, freight "Way" cars, and for wrecking equipment cars in working around gasoline or inflammable freight.

It consists of a substantial sheet steel box finished with two coats of baked on black japan, equipped with comfortable carrying handles, strong hinges and toggle catch. Upon one end of the cover is mounted an automobile type of spot lamp which has a heavy housing containing twelve feet of extension wire cord automatically wound on a spring reel, a highly polished parabolic reflector and a standard 6-8 volt 21 C.P. bulb, rated at a nominal current of 2.81 amps.

Portable Battery Lighting Outfit

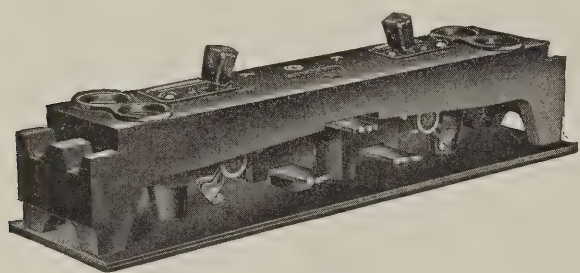
A swivel mounting provides for swinging the lamp in any direction without moving the box and also allows of disconnecting the lamp from the box and carrying in the hand for inspection purposes within a radius of twelve feet from the box. The lamp housing includes a switch for turning the light on and off and also means for focusing the bulb so that perfect projection can be attained with any bulb.

Upon the other end of the cover of the box is mounted a small housing which contains a standard S. A. E. double contact socket in which is placed a standard S. A. E. double contact plug which may be used for connecting in a red tail lamp circuit or ignition circuit or both.

The outfits are made in three sizes of varying battery capacity and are admirably adapted to the work for which they are designed. The model chosen will depend entirely upon the number of light hours required per charge.

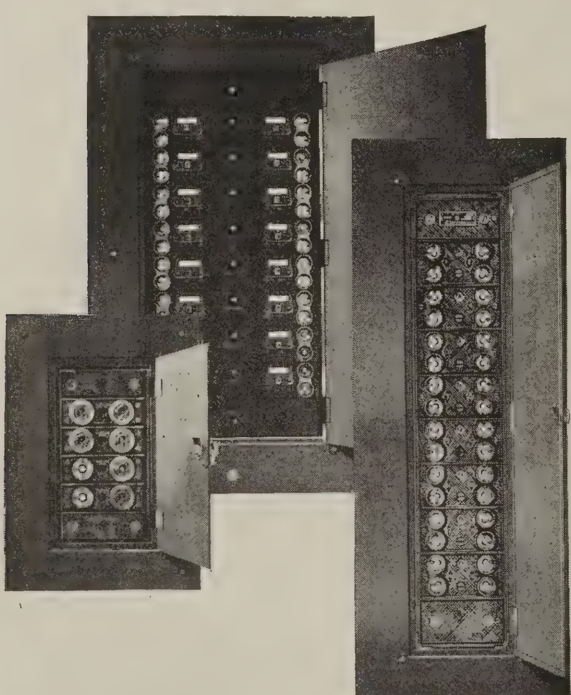
Sectional Panel Boards

The Frank Adam Electric Company, St. Louis, Mo., is now marketing a line of panel boards which can be made up in a great variety of forms by means of combining standard sections. One of these sections is shown in the smaller illustration and panel boards, made up of sections, are shown in the larger illustration. The sections are made in two sizes so that small sections can be used to fill a small cabinet, large sections can be used to fill a large cabinet or the large cabinet can be filled with small sections placed end to end. Combinations of large and small sections can also be used together.



One of the Larger Size Sections

The two sizes of sections are furnished in various types according to the users wish regarding cut outs, switches, etc. With all the various sections occupying the same, or multiples of the same space, only two widths of steel cabinets are required for all types, except when the number of circuits increases the required gutter space. This feature permits the manufacturer to carry standardized steel cabinets in stock ready for immediate delivery.



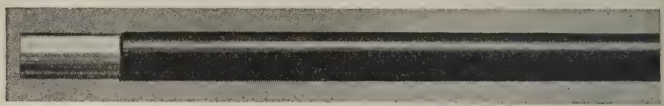
Panelboards Made-Up of Standard Sections

Headlight and Magnet Wire

The Rockbestos Products Corporation, New Haven, Conn., manufacturers of Rockbestos locomotive cab cord are now marketing a special headlight wire and a magnet wire. The headlight wire is insulated with highest grade asbestos, carefully impregnated to take care of the moisture conditions encountered in conduit service. It is unaffected by the cycles of temperature produced in locomotive service and is offered as a wire which will give increased service life with good insurance against failure in service.

Rockbestos Headlight Wire

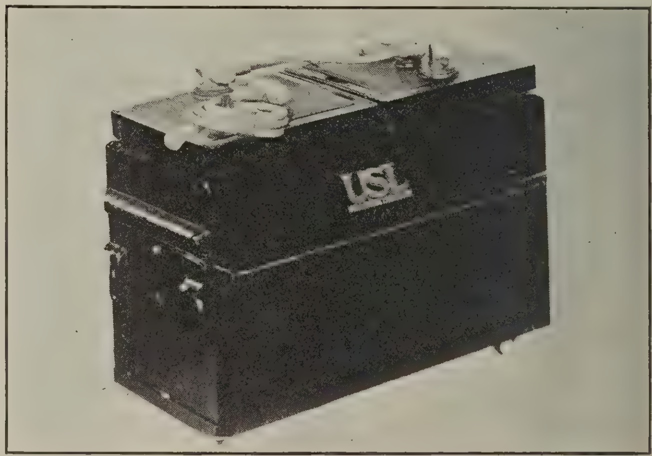
The magnet wire is made for use in winding headlight generator armatures and for this wire the Rockbestos Products Corporation has developed the P. N. finish. This finish provides a smooth tough surface, which greatly facilitates the winding of the coils. It also provides close adherence between the asbestos and copper, thus minimizing the tendency for the outer surface to slip while forming coils.



Rockbestos Magnet Wire

Paste Plate Battery for Car Lighting Service

The USL carlighting storage batteries as manufactured by the U. S. Light and Heat Corporation and the National carlighting storage batteries as manufactured by its predecessor, the National Storage Battery Company, have been furnished in the pure lead "Planté" type for 27 years.



New Battery for Car Lighting Service

To meet the demand for a storage battery for carlighting service of high capacity with space and weight limitation with minimum sacrifice of the essential characteristic of long service life and freedom from operating

trouble USL has developed a special heavy plate "Faure" or paste type battery with plates 11/32 in. thick for the positives and 7/32 in. thick for the negative.

The USL heavy paste plate battery represents a design embodying the experience gained in many years manufacturing of paste plate storage batteries for automobile starting and lighting and other service as well as carlighting.

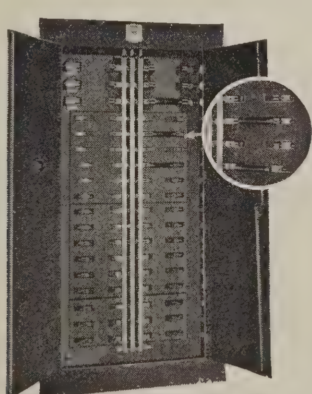
The question of interchangeability of containers for the heavy paste and the pure lead Planté carlighting battery has been given careful consideration, with the result that a 250 ampere-hour paste plate element is installed in the same size container as the 150 ampere-hour pure lead Planté element. Likewise a 500 ampere-hour paste plate element for heavy load cars such as diners, etc., is installed in the same size container as the 300 ampere-hour pure lead Planté type element used for straight passenger carlighting. This has particular advantage as regards replacement material since it is necessary to stock only two sizes of jars, covers, wood trays, etc., to provide service on four sizes of batteries ranging in capacities from 150 to 500 ampere-hours, which meet the requirements of practically all carlighting service.

Convertible Power Panel

The Square D Company, Detroit, Mich., have just announced a new power panel construction embodying several new features in panel board design.

Individual insulating bases set into slots in a steel grid make it possible to adjust, at any time, fuse jaw spacings to provide for either 30, 60, or 100 ampere fuses. This adjustment can be made by loosening several nuts in the steel grid, moving the bases to the desired distances and tightening up the nuts again.

Fuse jaws, connectors and solder lugs are mounted on the individual insulating bases in such a way that they



Power Panel That Is Convertible

can be removed from the front of the panel by means of a screwdriver. This will save sonsiderable time in replacing burned fuse jaws.

The construction is such that three-wire circuits can quickly and easily be converted into two-wire and vice versa.

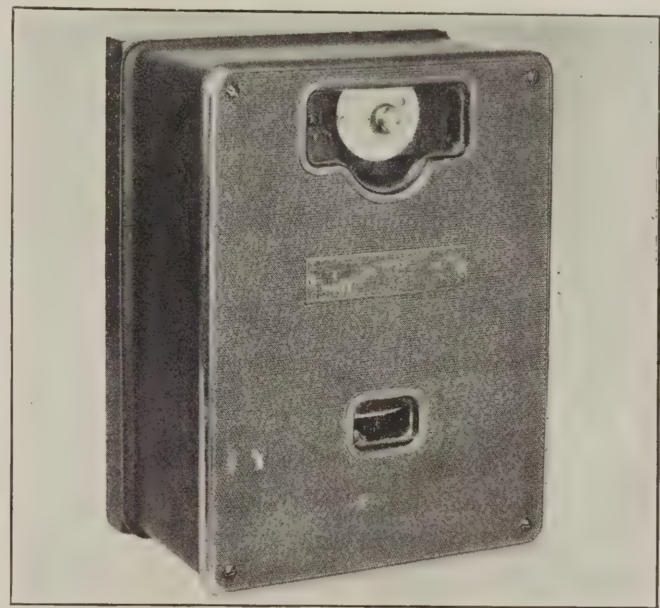
It is unnecessary to remove the heavy doors and side trims to make the circuit wires accessible. A split gutter wall, half of which is made removable by loosening several screws, makes it easy to have access to the circuit wires.

Convertible power panels are available in circuits of four or multiples of four. The fuse spacings will take care of 30, 60, or 100 amperes. Panels are supplied for 220, 440, or 600 volts.

New I. G. Relay

A new General Electric power relay can be calibrated without removing the cover by means of a knob projecting through the glass window at the upper part of the case. This relay is for use in limiting the power on distribution lines to a predetermined quantity. It has a large range of calibration, running from zero to 1,000 watts, secondary, heavy contacts are used, and the internal mechanism is very simple.

This relay is manufactured in three forms; the "IG-



Type I G-103 Power Relay

102," an "over power" and "under power" device with contacts for controlling either alternating or direct current, and two "over power" devices, one for alternating and the other for direct current, known as the IG-103 and IG-104, respectively. By rotating the knob at the window, the relay may be adjusted for operation at any deviation from the desired load. A graduated dial, mounted beneath a fixed needle, rotates with the calibrating knob, giving visible indication of the load setting.

New Across-the-Line-Starters

The Cutler-Hammer Mfg. Company, Milwaukee, has just completed the design of two automatic starters for use in connection with alternating current motor drives, requiring motors of small and average capacities which can be connected directly across the line and where complete motor protection is desired.

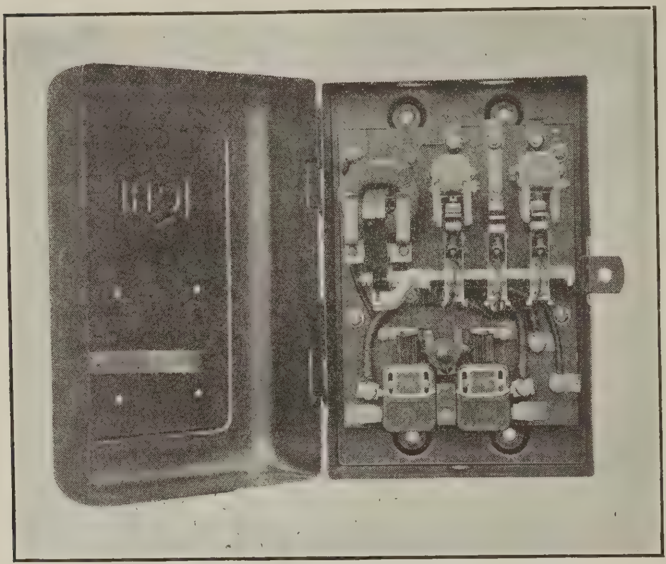
These starters are of small size, and rugged switch mechanism.

They are made in two types. One is a fully enclosed starter and employs a new positive acting, three pole contactor, together with a new thermal overload relay. This relay is extremely accurate, can be adjusted to individual

motor loads. There is nothing to replace after it has been tripped by an overload—just press the reset button.

The second is similar in all respects, except that thermal cutouts are furnished in place of the thermal overload relay. These cutouts employ a fusible link which must be replaced when blown by an overload.

The contact fingers used in both types of starters are accessible for inspection and easily renewed. It is not necessary to take the starter from the case nor to dismantle it in any way.

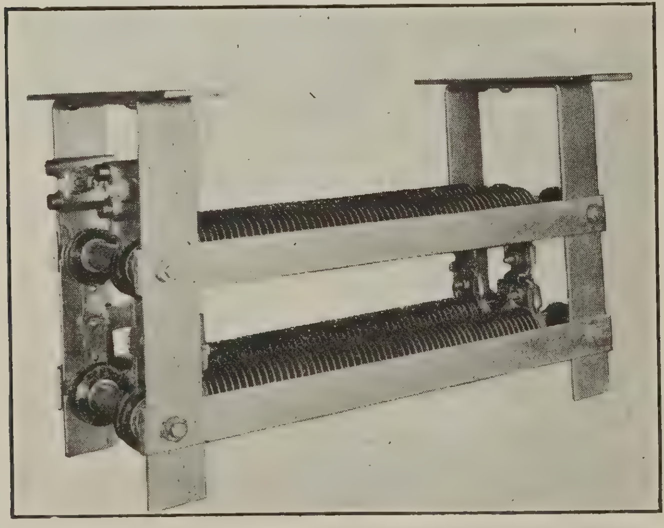


Fully Enclosed Starter with Thermal Overload Relay

One starter takes care of all motor sizes, which materially simplifies stocking since only the cutouts in the latter and the heater in the former need be changed to suit the ampere rating of the motor with which the starter is to be used.

Edgewound Resistor for Railway Service

The Monitor Controller Company, Baltimore, Maryland, has developed a railway mounting for its Edgewound resistor units. One of the chief features of this mounting is a special form of terminal clamp. These clamps are supported by the end rods composing part of the resistor mounting, which is entirely of steel, no cast-iron being used at any point. This gives a strong, rigid support for the terminal clamps and relieves the resistor elements from all cable strain. The cable ends are sweated into two cylindrical terminals which in turn are held firmly between the two jaws of the clamps.



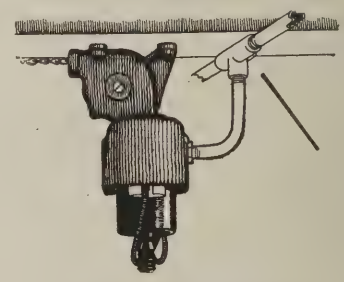
Side View of Edgewound Railway Resistor

The Edgewound resistor units consist of a nickel-copper alloy ribbon wound on edge in helical form and mounted on a steel-reinforced porcelain support which passes through the entire length of the unit, supporting and separating every convolution at two diametrically opposite points.

A system of terminals and taps enables a unit to be connected into a circuit, and to be interconnected with other units. The taps may be placed at any desired point along the resistor and may be changed at will. This perunits of accurate adjustment of the resistance steps.

Improved Safety Lowering Switch

The Thompson Electric Company of Cleveland, Ohio has improved its safety lowering switch by a number of changes in the original design. The new under-slung model is so constructed that all of the moving parts except the wheel come down to the ground when the lamp is lowered. The latch dog is installed so that it can be easily removed for cleaning. In the new model the line wires, as they enter the upper member of the hanger, are enclosed. Another change provides a swiveling arrangement for dead ending the chain in the lower member enabling the lamp to rotate freely so as to bring the contacts into proper alignment for setting. Provision has also been made for enclosing the chain in conduit where necessary.

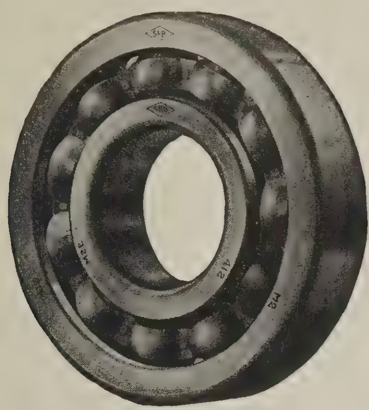


Safety Lowering Switch

Molybdenum Steel Ball Bearings

Standard Steel and Bearings, Incorporated, Plainville, Conn., has developed a chrome molybdenum electric furnace steel for making balls of one inch diameter or larger for ball bearings. The advantages claimed for the molybdenum steel balls are increased toughness and breaking strength, greater and more uniform hardness, extraordinary load carrying capacity and maximum ball endurance. The bearings are made as both single row and double row annular bearings. The inner and outer rings are made of high carbon chrome alloy steel and the grooves are very deep with curvatures which confrom very closely to the contour of the balls. The reason for the deep grooves is to provide greater surface contact

with corresponding increase of load carrying capacity. The balls are spaced by rigid steel separators of the "stayrod" type. An S. R. B. single row bearing is designed to carry a thrust load in either direction equal to

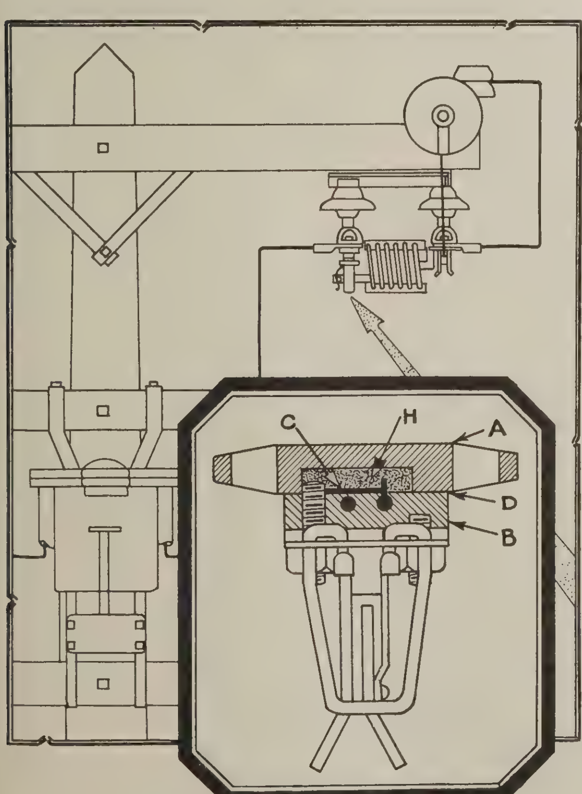


The Larger Size S. R. B. Bearings Are Now Made With Molybdenum Steel Balls

50 per cent of its rated radial capacity which may be applied simultaneously with full radial load. The double row bearings are designed to carry a thrust load in either direction equal to 100 per cent of the rated radial capacity.

New Type Pole Fuse

The Line Material Company of South Milwaukee, Wisconsin, has recently developed a type of pole fuse de-



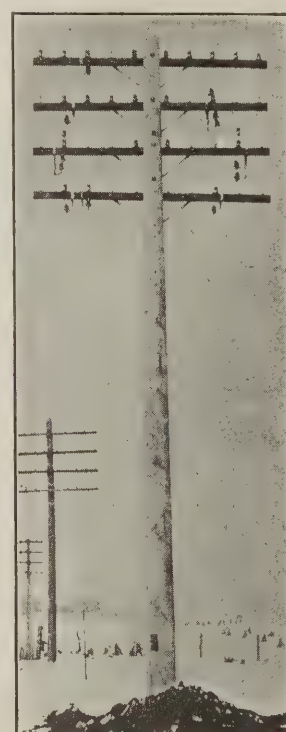
Pole Fuse for Low Current Circuits

signed to furnish fuse protection as low as one-half ampere. The device is of the explosion fuse type which utilizes an explosive compound ignited by an excessive flow of current which breaks the arc and gives the indication that the fuse has blown.

The Raymer fuse, as it is known, consists of two Bakelite members. *A* and *B* are cemented together at the point *D* with Bakelite cement. These members contain the chamber *H* which contains the fuse wire *C*. The chamber *H* is filled with the explosive substance which, after the fuse wire attains a pre-determined temperature, causes a rupture of the fuse wire and the Bakelite strips *A* and *B* at the point *D*, thereby opening the circuit, breaking the arc and giving the indication.

New Design of Concrete Poles

A design of concrete poles which successfully copes with the problem of the growing scarcity of timber, and meets the demands for longer life, greater strength and increased safety factors in telegraph, trolley and transmission lines is that incorporated in the Hollowspun concrete poles manufactured by the Westinghouse Electric & Manufacturing Company.



Hollowspun Concrete Poles Meet Severe Requirements

In the Hollowspun process, the reinforcing steel, after being accurately computed for the particular class of pole to be made, is held rigidly in place.

The complete reinforcing cage is then placed in a horizontal form and held at the desired distance from the surface of the form by concrete buttons which become part of the finished wall of the pole. Concrete is added and the entire form rotated at high speed developing centrifugal force sufficient to compact the concrete into a very dense wall, leaving a cylindrical opening in the center running through the length of the pole.

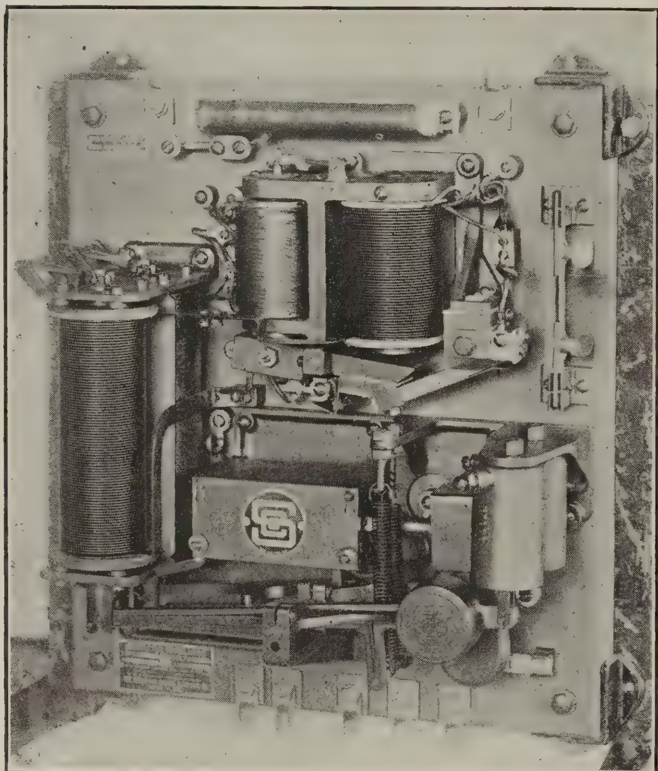
Removable steps may be made for these concrete poles by embedding bronze inserts in the concrete and using these as inserts for holding the ordinary pole steps. Standard cross arms and other equipment now in use can also be applied to these Hollowspun poles.

The use of these concrete poles for telegraph and transmission lines makes possible a considerable increase in the capacity of the lines, and thus permits the reduction of the number of poles per mile, or an increase in the number of wires without reducing the factor of safety. Maintenance costs are practically eliminated by the use of these concrete poles.

The advantages of strength, durability and attractive appearance make these Hollowspun posts particularly applicable to trolley lines or electrified sections of steam railroads.

New Safety Panel

A new regulating panel recently added to the line of the Safety Car Heating and Lighting Company of New Haven, Connecticut, is known as the FF-10 generator regulator. The principal change lies in a new switch mounted on the company's standard type FF field regulator. In the type FF field regulator with the old



New Safety F F 10 Generator Regulator

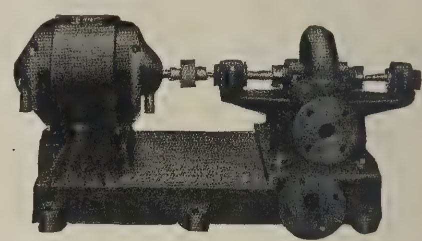
steel switch a high resistance was connected across the contacts of the switch in order to insure a proper polarity of the generator. The drain on the battery with the new switch is no greater than it was formerly with the dead resistor, but this small amount of the "sneak" current is now utilized for two purposes—energizing the main field circuit and locking the main switch open.

Reversible Pump That Needs No Tank

The M. J. Finn Pump Manufacturing Company, Pittsburgh, Pa., has recently placed on the market a new motor driven centrifugal pump, which by its design eliminates many parts and which, through its application to heating systems, effects a considerable fuel saving. In its operation as applied to a heating system, it tends to create a vacuum, returns the condensation from the return lines, coils or radiators that are on a line with, or below the level of the water in the boiler, thus eliminating any sluggishness in the heating system. At the same time it introduces live steam into the returns, throwing off heat into rooms instead of cold condensation. The vacuum that this pump creates permits the water to be boiled in the boiler at a lower temperature than otherwise possible, and thus effects the fuel saving.

The design of the pump is simple, consisting of merely a bronze centrifugal pump with a bronze impeller. This impeller consists of a wheel revolving inside the pump-case. As it revolves it touches only the water, and does not touch or rub against any metal part, reducing the possibility of wear. With this construction many parts are eliminated doing away with gears, pulleys, buckets, belts and pump valves.

This electrically driven pump has a wide variety of applications. It may be used advantageously in condensation, water supply, refrigeration, circulation and heating systems. It is driven by a Westinghouse ¼ hp. motor direct connected through a flexible coupling and will pump water from wells, cisterns or streams to the place it is



The Pump Is Made of Bronze and Is Driven by a ¼ Hp. Motor

wanted without the use of a tank. Another distinctive feature of this device is that either opening in the pump may be used as the outlet or inlet by merely reversing the motor. It is impossible to overload the pump since the capacity remains nearly constant regardless of the load.

Solderless Wire Connectors

For making connections in junction boxes and other places where wires are soldered and tapped, the Ideal Commutator Dresser Company of Syracuse, Illinois, has developed its "Ideal" wire connector. The device is

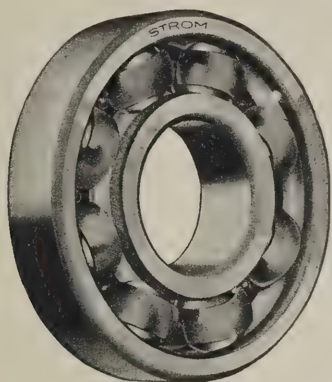
Showing Application of Connector

shaped somewhat like a thimble embedded in the center of which is a helical copper coated steel spring. The spring threads itself onto the twisted wires, binding them together and also acting as a conductor itself. The insulating shell

extends well over the insulation on the wires making the joint practically waterproof and unaffected by time. It is claimed that a great saving of time can be effected over the soldered and tapped method of making connections.

Super Strom Ball Bearings

Among the recent developments in the line of Strom Ball Bearings is the design known as the Super Strom. The outside dimensions are the same as those of the international standard sizes for light, medium and heavy

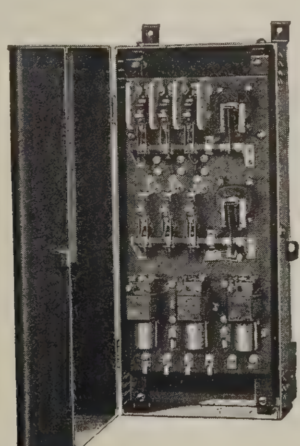


The Super Strom Bearing

duty. The design incorporates deep grooves and increased number of sizes of balls resulting in larger radial load carrying capacity as well as thrust in both directions. Retainers which are of the wide ribbon type prepared from heavy stock form spherical pockets for the balls. Super Strom bearings are made in a large variety of sizes for light, heavy and medium duty. The Strom bearings are marketed by the Marlin-Rockwell Corporation of Chicago.

A. C. Automatic Starter

An a. c. automatic starter of the primary resistor type has been recently brought out by the Industrial Controller Company of Milwaukee, Wisconsin. The starter consists



A. C. Automatic Starter with Push Button Control

of two magnetic contractors, an accelerated relay, two overload relays and a resistor. The units are mounted on an ebony asbestos panel and the whole is enclosed in a dust proof cabinet.

The resistor is supplied with three taps so that it can be adjusted to meet starting load conditions. The starter is actuated by push button control. It is designed to operate on 25 or 60 signal current and is available in ratings of 5, 7½ and 10 hp.

Unit Heater for Railroad Shops

The ILG unit heater recently developed by the ILG Electrical Ventilating Company, Chicago, is a cabinet open at both ends in which is housed heating coils for steam or hot water and a self-cooled motor propeller fan. This cabinet serves as a heating chamber for the air which is drawn in over the heated coils on the intake side at low velocity—about 500 feet per minute and discharged in

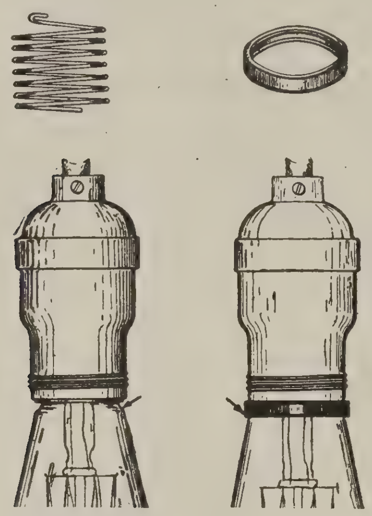
Unit Heater Installed in New York Central Locomotive Repair Shop

volume at high velocity at about 200 feet per minute. The heaters are intended for shops, factories and warehouses and similar localities and it is claimed for them that they effect a considerable saving in fuel as well as greater rapidity in warming up the buildings.

Lamp Locking Device

A device designed to prevent the removal of lamps from sockets after they have soon been installed has recently been developed by the Ren Manufacturing Company of 355 Main Street, Winchester, Massachusetts, and placed on the market under the name of Ren-Lock. The device consists of a spiral spring and a grooved washer which can be applied to any lamp socket. The spring is introduced into the inside of the shell of the socket and is so attached to the grooved ring which fits over the narrow part of the lamp, that when once the lamp has been screwed into position, it is impossible to remove it without breaking. In making removals the old lamp is first broken

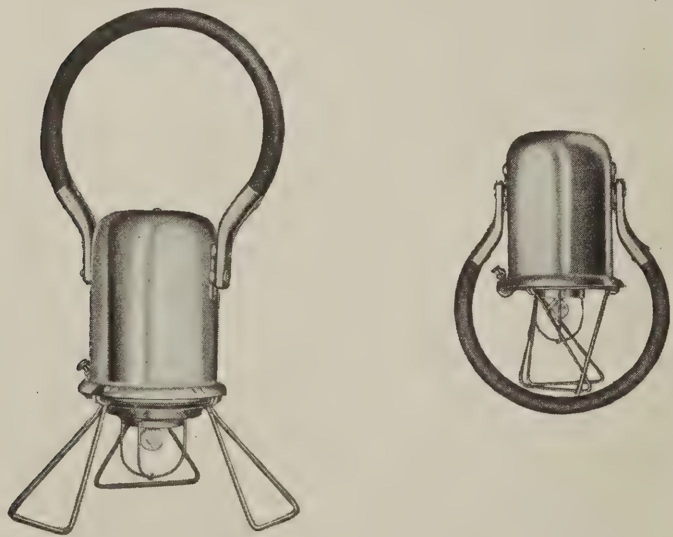
which permits the grooved washer to be taken off. This will expose the end of the spring which should be pushed backward in a counter-clockwise direction. This movement releases the grip of the spring on the old lamp base The spring and washer are uninjured by this process and may be used any number of times.



Showing Parts of Locking Device

Folding Electric Lantern

The Federal Electric Company, Chicago, Ill., has developed a folding hand lantern known as model H. The legs and bale of the lantern can be folded as shown in the illustration, so that the lantern can conveniently be carried in a coat pocket and quickly withdrawn by the projecting handle. The lantern uses a six-volt, white or ruby miniature base bulb and a six volt, four cell battery which weighs 19 oz. The weight of the lantern complete with battery is 2¼ lb. The over-all height with the handle up is 14¾ in. The dimensions of the lantern when folded are 9½ in. by 7 in. by 4 in.

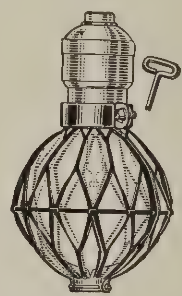


The Federal, Model H, Hand Lantern, Open and Folded

The lantern is lighted or extinguished by means of a switch so placed as to be out of the way of accidental operation or injury. The switch is doubly insulated against shorting and is protected from freezing. A further precaution is found in the fact that no exposed metal parts which come in contact with the ground are in contact with either pole of the battery at any time.

Key Locking Guard

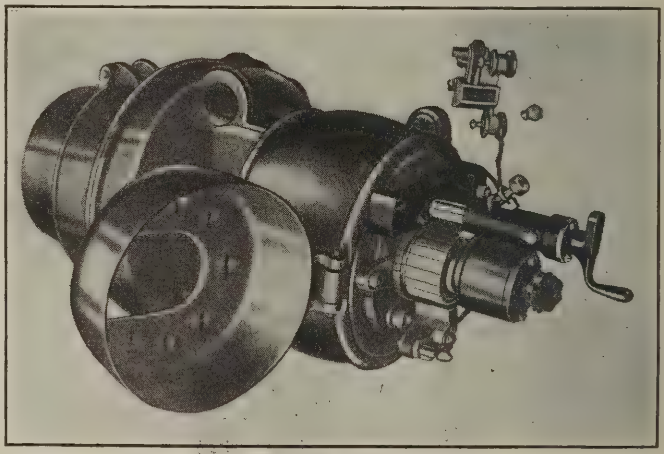
Lamp guards of reinforced expanded metal have been recently added to the line of the Flexible Steel Lacing Company of Chicago. These lamp guards are made locking or non-locking as required. The one shown in the illustration is known as a key locking guard of the regular type as distinguished from the reflector type also manufactured by the company. The guards are made for practically all types of incandescent lamps.



Flexible Guard and Key

Commutator Turner for Turbo Generators

A device which makes it possible to turn or smooth commutators of turbo-generators without removing the armatures from the generator frames has recently been developed by the Sunbeam Electric and Manufacturing Company of Evansville, Ind. To adjust the Sunbeam commutator turner, as it is called, on a Sunbeam R E-3, it is only necessary to remove one brush holder, apply the turner and turn on the steam. While the generator is running at full speed a light cut may be taken across the face of the commutator. The Sunbeam turner is accurately made and finished in a manner of machine tools.



Application of Commutator Turner

General News Section

The New York Office, eastern district, of The Johns-Pratt Company of Hartford, has removed its office from 41 East Forty-second street, New York, to 20 Vesey street, Room 610, New York City, effective October 1, 1925.

The Electric Controller & Manufacturing Co., Cleveland, Ohio, announces the appointment of Eicher & Bratt, Seattle, as representatives for the sale of its control equipment in the states of Oregon, Washington, Alaska and the "Pan Handle" district of Idaho.

The Black & Decker Manufacturing Company has removed its Boston, Mass., branch office to new and larger quarters at 62 Brookline street, Boston. This office is in charge of A. D. Geiger, recently appointed branch manager of the Boston territory to succeed D. G. Caywood, who has been assigned to special work.

The Kuhlman Electric Company, Bay City, Michigan announces the appointment of the D. H. Braymer Equipment Company, 727 W. O. W. Building, Omaha, Nebraska, as district representatives in Iowa and Nebraska. The D. H. Braymer Equipment Company will handle Kuhlman power, distribution and street lighting transformers.

The Interstate Commerce Commission, on petition of the New York Central for the omission of the Pittsburgh & Lake Erie and the Boston & Albany from the provisions of its second train control order (January 14, 1924), has granted the petition insofar as the Pittsburgh & Lake Erie is concerned but has denied it as to the Boston & Albany.

The Oregon-Washington Railroad & Navigation Company has petitioned the Interstate Commerce Commission for a modification of its report of July 31 on the O.-W. automatic train control installation. The commission conditions its approval on the addition of a feature requiring the engineman to "acknowledge" at succeeding stop signals; this, says the petition, is neither necessary nor desirable.

Westinghouse Electric & Mfg. Co. announces the appointments of John L. Crouse, formerly manager of the development and supply division of the railway sales department, as assistant to manager of the railway department, and A. B. Gibson, for the past six years manager of the Westinghouse technical night school, has been appointed to succeed Mr. Crouse as manager of the development and supply division.

In a collision of passenger trains, seven miles east of Thomasville, Ga., on the Atlantic Coast Line, on September 27, two passengers and three employees were killed and the conductor, the engineman and 14 passengers were seriously injured. Both locomotives and several cars were badly wrecked, all the cars except one being of wooden construction. Eastbound train No. 180, running behind time and in disregard of an order to wait at Newark, Ga., collided at full speed with westbound train No. 185.

The Central of New Jersey recently purchased from the Ingersoll-Rand Company, the General Electric Company and the American Locomotive Company—which companies co-operate in its manufacture—one 60-ton oil-electric locomotive, the first oil-electric locomotive to be purchased by a railroad in the United States. The locomotive will be delivered in about one week's time and will be used in the New York district.

The seventy-third anniversary celebration of the Chicago, Rock Island & Pacific, held in Kansas City, Mo., on October 12 and 13, was the occasion for the gathering of representatives from all divisions of the system. The attendance numbered 2,000 employees and officers, including a large number of pensioners and members of the 25-year club; officers and employees who have been in the service of the Rock Island for 25 years or more.

Gerard Swope, president of the General Electric Company has announced the appointment of T. W. Frech of Cleveland, Ohio, and W. R. Burrows of Harrison, N. J. as associate managers of the incandescent lamp business of the company. They will relieve Messrs. G. F. Morrison, F. S. Terry, and B. G. Tremaine from the burdensome part of the responsibilities which have devolved upon them as managers of the incandescent lamp business of the company for many years.

In a collision of fast passenger trains on the Nashville, Chattanooga & St. Louis near Chickamauga, Tenn., on September 24, one passenger was killed and about 30 passengers and four trainmen were injured. Train No. 94, northbound, collided at full speed with No. 95, southbound, and the locomotive and several cars of the northbound train fell down a bank. Press reports say that the southbound train was running in disregard of an order to wait for the northbound at Chickamauga.

Otis B. Duncan, 53 West Jackson Blvd., Chicago, Illinois, formerly with the Western Electric Company is now a distributor of railroad and industrial supplies and is representing the following companies; The Electric Products Company, manufacturers of battery charging equipment; The Northwestern Motor Company, manufacturers of Railway Section and inspection cars; Johnston Manufacturing Company, manufacturers of oil burning rivet forges, torches, etc.; The Illinois Electric Company, electrical supplies: The Green Corporation, commutator stones and accessories; Becker Brothers, carbon and metallic brushes and contacts.

Albert Stone, 90 years old, a clerk in the office of the auditor of passenger accounts of the New York Cen-

tral, New York City, the railroad employee longest in active service, celebrated this week his birthday and at the same time the 75th anniversary of his employment by the New York Central and its predecessor, the New York & Harlem. Among those present were President Crowley and many other officers of the road; and Mr. Stone was presented with an engrossed set of resolutions. This testimonial was signed by chairman Chauncey M. Depew who has been in the service only 59 years. Mr. Stone was offered a pension long ago, but begged the privilege of continuing at work.

Electrification of Austrian Railways

Preliminary plans for the electrification of the Austrian Federal Railway lines from Salzburg to Woergl and from Kufstein to Brenner are well under way, according to the published report of the electrification bureau of the railways, says Commerce Reports. These are the projects for which the League of Nations released a portion of the foreign credits a month ago, and several large orders have already been placed. The Austrian Siemens-Schuckert-Werke have received an order for the construction and equipment of the substation at Feldkirch, and the construction of transmission lines from Ruetzwerk has been awarded to the A. E. G. Union and the Oesterreichische Bergmann-Elektrizitaets-gesellschaft. This latter concern is also constructing the cable from Bludenz to Feldkirch.

Seven fast mountain passenger locomotives have already been shipped and are in operation between Innsbruck and Bludenz. In addition, 20 passenger locomotives have been ordered, of which 19 are already furnished; 12 of these are in use along the Attnang-Steinach line, and five on the line from Innsbruck to Bludenz. Furthermore, 20 freight locomotives have been furnished and are in operation, and four fast freight locomotives for use in the valley are under construction.

The total expenditure on this scheme during the second quarter of 1925 amounted to 8,525,000 schillings, of which 5,905,000 schillings were devoted to new construction and the remaining 2,621,000 schillings to the purchase of rolling stock. (The schilling exchanges at 14.1 cents.)

General Electric Company to Erect New Building

Plans for the immediate erection of a large warehouse and office building at Santa Fe avenue and Fifty-second street, Los Angeles, by the General Electric Company, have been announced. The plant, which is to be used as a distributing center, will cost about $1,000,000, including land, buildings and equipment.

The plans being prepared by the Austin Company of California, call for a warehouse three stories high and designed to handle four additional floors. The warehouse besides housing handling machinery to move the stock wil include a cafeteria for employees.

The office building will adjoin the warehouse, fronting on both Santa Fe avenue and Fifty-second street, and will be two stories high. One of the outstanding features of the office building is that it will be heated by electricity. Numerous departments of the General Electric Company at present are scattered over the city, but as soon as the leases on the places expire they will be moved to the new central location. The building is expected to be ready the first of the year.

Tunnel Disaster at Richmond

In the caving in of a tunnel of the Chesapeake & Ohio in Richmond, Va., on Friday evening, October 2, an engineman and a fireman were killed and 40 workmen had very narrow escapes. The tunnel extends beneath the west side of Jefferson Park and is one which was abandoned several years ago. The workmen who were the victims were engaged in repair work preparatory to putting the tunnel again in service. A locomotive and several cars, which had just been run into the tunnel, were buried beneath a mass of earth near the western end. This tunnel was part of a line connecting the city with the lower river front and was completed in 1873. It was in regular use until 1902. Large masses of blue marl, softened by heavy rains, are said to have been the cause of the trouble.

Additional Airplane Mail Routes

The postmaster general announced on Wednesday of this week that proposals have been accepted for operating new airplane mail lines, soon to be established, as follows: New York-Boston route to Colonial Air Lines, Inc., Naugatuck, Conn.; Chicago-St. Louis, Robertson Aircraft Corporation, St. Louis, Mo.; Chicago-Dallas-Fort Worth, National Air Transport, Inc., of Chicago; Salt Lake City-Los Angeles, Western Air Express, Inc., of Los Angeles; Elko-Pasco, Walter T. Varney, of San Francisco. No awards were made for the Chicago-Birmingham and Chicago-St. Paul-Minneapolis routes.

Proposals for four additional routes will be opened on November 21.

Brown-Boveri Company Plans Completed

Financial and organization plans for the American Brown-Boveri Company, of Switzerland, which is to operate the New York Shipbuilding plant in Camden, N. J., for the manufacture of electrical equipment, were announced recently by the bankers affiliated in the transaction.

The New York Shipbuilding Corporation will recapitalize under the name of American Brown-Boveri Electric Corporation. Notices of a meeting to be held on Oct. 14 to vote on the plan have been sent to the stockholders. Purchase of the Condit Electrical Manufacturing Company, of Boston, and the Scintilla Magneto Company, of Sidney, N. Y., also is announced.

Brown, Boveri & Company, Ltd., of Baden, Switzerland, will supervise the management of the American corporation. To insure continuity of administration, more than a majority of the founders' stock, of which Brown, Boveri & Company, Ltd., will be large owners, will be held in a voting trust.

The properties taken over have a value in excess of $30,000,000 according to a recent appraisal by the J. G. White Engineering Corporation.

The plants of the New York Shipbuilding Corporation comprise 191 acres of land with nearly a mile of navigable water frontage on the Delaware River. It is estimated that an expenditure of $500,000 on these plants will make possible the production of $40,000,000 of electrical equipment annually without in any way affecting the present shipbuilding operations of the company.

Laurence R. Wilder, who will be president of the

American Brown-Boveri Electric Corporation, says in part:

"In the contract it is also provided that this corporation shall have the right to have manufactured for it in any of the various plants of the Swiss or associated companies at minimum cost, all machinery, equipment or parts which the corporation finds inadvisable to manufacture itself, or more economical to have made abroad.

"The arrangement with the Swiss company also provides that the corporation obtains all rights to American patents, designs, construction experience, data and knowledge now possessed, or which may be hereafter acquired by the Swiss company and its subsidiary or associated companies."

J. Elink Schnurman, executive director of Brown, Boveri & Company, Ltd., will be chairman of the board, and personally supervise its affairs, making his headquarters in this country. Marvin A. Neeland, now president of the New York Shipbuilding Corporation, will be chairman of the executive committee.

In connection with these acquisitions a nation-wide syndicate, headed by Pynchon & Company, offered on Oct. 8 for public subscription 260,000 shares of American Brown-Boveri Electric Corporation participating stock, the price being $50 a share. American engineers will be added to the staff of the American Brown-Boveri Electric Corporation as well as engineers from Brown-Boveri and associated companies.

Chicago Terminal Problem

The six railroads whose land holdings involve them in the proposed straightening of the south branch of the Chicago river between Polk and 16th streets, Chicago, have agreed to reply to the proposal of the city that the railways pay the cost of the straightening of the river. The river straightening is considered an important step towards the construction of a passenger terminal to replace the present LaSalle street, Dearborn street and Grand Central stations. The report of a committee appointed by the mayor of Chicago intended to demonstrate that the railways would benefit from the river straightening to an amount sufficient to cover the cost of the work, was presented to the representatives of the six roads in Chicago on September 14. The roads involved are the Pennsylvania, the Baltimore & Ohio Chicago Terminal, the Chicago & North Western, and the Chicago, Burlington & Quincy with property on the west side of the river, and the Baltimore & Ohio, the Chicago, Rock Island & Pacific, and the New York Central, with property on the east side of the river.

Oil-Burner Runs 3,700 Miles With but One Rest

Locomotive No. 2517, of the Great Northern, a new oil-burning engine, Class P-2, on Wednesday morning, September 30, completed a round-trip, Seattle, Wash., to St. Paul, Minn., and return, in less than five days. Thirteen different enginemen, each way, were successively in charge. The length of the route traversed is given by the railroad company in one statement as 3,700 miles (or 1,850 miles each way), and in another as 3,600 (1,800 each way). The Official Guide records Seattle as 1,775 miles from St. Paul.

The eastbound train was a special, consisting of 19 cars, 18 of them loaded with silk, and the westbound was No. 27, the regular fast mail, scheduled to run through in 47 hours, 30 minutes. The eastbound run, 52 hours, 25 minutes, was five hours shorter than the schedule of the Oriental Limited, and on the westbound considerable lost time was made up. With the 19-car train a helper was used for a distance of approximately 18 miles ascending the Rocky Mountains.

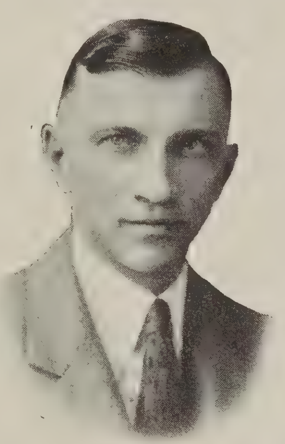
Eastbound the train left Seattle at 4:30 p. m., Pacific time, on Friday, September 25, and arrived at St. Paul on Sunday evening, September 27, at 10:55 p. m., Central time.

Westbound, Train 27 left St. Paul on Monday morning about 20 minutes late (scheduled to leave at 8:45), and arrived at Seattle, Monday morning on time (6:15 a. m., Pacific time).

Calculating the distance at 3,600 miles, the average rate of speed, including the nine or ten hours in the roundhouse at St. Paul, was better than 32 miles an hour, which may be considered as a notable performance for this type of motive power.

Personals

E. H. Hagensick, whose recent association with the Pyle National Company of Chicago was noted in the September issue of the *Railway Electrical Engineer,* entered the University of Nebraska in 1901. After spending one year in the university he accepted a position in the freight department of the Chicago, Burlington & Quincy Railroad, Lincoln, Nebraska. Later Mr. Hagensick returned to the university and completed his course, graduating in 1906 as a B. S. in electrical engineering. Upon leaving college, he went to work for the Union Pacific Railroad as a special apprentice in the shops at Omaha, Neb. After two years and a half in the shop, Mr. Hagensick spent several years in the drafting room as electrical and mechanical draftsman and at the end of this time was appointed general electric foreman having charge of electrical construction and maintenance over the entire railroad.



E. H. Hagensick

In 1913, Mr. Hagensick resigned to accept a position of superintendent of electric line for the Omaha & Council Bluff Street Railway Company where he had charge of all electrical work in the power house, substations and outside distribution. This position he resigned in 1919 to become electrical engineer for the Union Pacific Railroad which position he held until August 1 of this year when he resigned to accept the position with the Pyle National Company as noted above.

Trade Publications

Electric Storage Battery Company, Philadelphia, Pa., has just issued a large illustrated folder containing 26 photographs that show the various uses of Exide batteries.

The Diamond Power Specialty Corporation, Detroit, Mich., has reprinted a bulletin entitled "The Best Paying Investment in the Power Plant." This bulletin features Diamond Valv-in-Head Blowers, and contains information and data which should be of interest and value to the power operator.

The Chicago Fuse Manufacturing Company, Chicago, has just issued an eight page pamphlet describing and listing the ferrule contact and knife blade contact "Union" renewable fuses. The fuses listed include sizes from one to 60 amperes for the ferrule contact type and 65 to 600 amperes for the knife blade contact type, 250 and 600 volts.

The Lincoln Electric Company, Cleveland, Ohio, has recently published an 84-page paper covered booklet known as the Lincoln Stable Arc Welder Construction Manual. The subject matter of the manual is divided into nine lessons and covers the various types in welding. Considerable information is presented in the methods of making a large variety of welds.

Concerning Insulation Testing is the title of a small illustrated booklet recently issued by James G. Biddle, Philadelphia, Pa. The pamphlet deals with the principles and practices of insulation testing with special reference to the "Meg". It is known as pocket manual 1060. The booklet consists of 48 pages and gives specific details regarding the methods and procedure in making insulation tests on various circuits.

Albert & J. M. Anderson Company, Boston, Mass., has recently issued its 72 page bulletin known as bulletin No. 38, illustrating and describing the Anderson charging plugs and receptacles. A large number of plugs and receptacles of various types and for various uses are shown. From page 25 to page 46 the bulletin deals exclusively with such equipment as is used by the railroads. List prices are given for all of the apparatus shown.

"Capacitors" is the title of a 24-page bulletin just issued by the General Electric Company, describing the value of this device in power factor correction on electric generating and distribution systems and for direct installation at motor terminals on low voltage circuits. Details are given as to operation, location, etc. Illustrations in the form of charts, diagrams, tables and photographs are used. The bulletin bears the designation GEA-77.

The Okonite Company, Passaic, N. J., has recently issued two circulars announcing the formation of the Okonite-Callender Cable Company, Inc. This latter company has been formed for the purpose of manufacturing impregnated paper cables for voltages from 33,000 to 55,000. These cables have been manufactured in London, England, by the Callender Cable & Construction Company for many years, and have been used for voltages in excess of 33,000 since 1915.

The Kuhlman Electric Company, Bay City, Michigan, has recently published an interesting handbook on the electrical transformer. This bulletin is out of the ordinary in that the manufacturer does not talk about his product in the text. The new Kuhlman bulletin is brimful of practical engineering data and material for the electrical or consulting engineer, and the man who operates transformers. The title of the handbook is "30 Years of Uninterrupted Service to the Electrical Industry."

Chas. Cory & Son, Inc., New York, has recently issued a 12 page bulletin, illustrating and describing the Cory-Recony Valve Control which is designed for motor operation of valves. Among the features mentioned in the bulletin are remote control, separate lower panel in which all circuits are opened and closed, electrical braking, permitting seating with full power, easily seating limit switch with positive adjustment, position and manual declutch signal lights at the control station and any angle installation.

The Electric Controller & Manufacturing Company, Cleveland, Ohio, has recently issued four bulletins illustrating and describing its equipment. The first of these bulletins, known as No. 1033-B, covers pressure regulators and cushion tanks of both a.c. and d.c. The second bulletin, 1040-B, describes safety limit switch for d.c. motors. Bulletin No. 1042-E deals with automatic compensators for a.c. squirrel cage motors and the final bulletin, No. 1048, covers the type ZO. starting switches for small a.c. motors.

The manually and electrically operated oil circuit breakers, types D, F-1, F-2, and F-3 manufactured by the Westinghouse Electric and Manufacturing Company, are described in a new leaflet recently issued. The types D and F oil circuit breakers comprise a complete line of moderate capacity, non-automatic and automatic, manually and electrically operated outdoor circuit breakers. The construction of the tanks, tank linings, mechanism and contacts is fully described, an account being given of both the distinctive features of both the outdoor and subway types.

The Westinghouse Electric and Manufacturing Company announces the Circular 1737—Adequate Lightning Protection—which describes the new Autovalve lightning arresters. A short account is given of the general principle of lightning arresters, characteristics of surges, danger of high voltages and steep wave fronts, and the requirements for lightning arrester characteristics. The circular is profusely illustrated, and in addition to several curves and sketches includes a map prepared by the U. S. Weather Bureau, showing the average number of thunder storms per season in the United States.

New Locomotive Data Pages:—As an addition to the loose leaf set of Electric Locomotive Data published by the Westinghouse Electric and Manufacturing Company, this company has now issued six additional pages devoted to the Baldwin-Westinghouse locomotives recently furnished to the Chilean State Railways and the Paulista Railways of Brazil. There is one page devoted to each, the express passenger, local passenger, road freight and switching locomotives for the Chilean State Railways, and the passenger and freight locomotives for the Paulista Railways. These may be obtained by requesting Leaflet 20190 Sheets 15 to 20 respectively from any Westinghouse District Office or from the Publicity Department at East Pittsburgh.

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The Virginian Electrification

A hearing before the Interstate Commerce Commission was begun on October 12 on the application of the Norfolk & Western for authority to lease the Virginian for 999 years, at a rental covering taxes, operating expenses and six per cent dividends on the preferred and common stocks. "By using the excess power and electric locomotives of the Virginian," said the counsel, "the Norfolk & Western expects to save a capital expenditure in connection with electrification of its own line from the coal field west to Williamson that may amount to $10,000,000."

The original Virginian contract amounted to $15,000,000 and covered the electrification of 13 miles of line with 213 miles of track and included locomotives, power house equipment, transformer stations, and other electric apparatus. At present the section from Mullens, W. Va., to Princeton, W. Va., a distance of 38.4 miles, has been electrified. From the above quotation it would appear that if the lease is made, further electrification of the Virginian will be discontinued for the present and the excess of Virginian power and equipment will be used in extending the Norfolk & Western electrification westward. The part of the Virginian now under electric operation includes all of the heavy grade against loaded train movement—the part that requires by far the largest number of locomotives per mile of track. The Virginian installation represents the maximum of what has been done in hauling heavy trains on steep grades, but the equipment is able to take care of a much more frequent train movement than present traffic conditions require. It is probable that the Norfolk & Western and the Virginian will hold the record for heavy train movement for some time to come.

The New Car Lighting Lamps

A new line of inside frosted lamps for train lighting, known as the Ideal line, has been proposed by the Mazda lamp manufacturers which it is hoped will eventually displace all of the different types of lamps now in service. These will be made in four or five sizes, namely 15, 25, 50 100 and probably 75 watts, and in two voltages, 32 and 64. If the 75-watt lamp is included it will be made in the same bulb as the 100-watt size and the line will then consist of ten different lamps including four different bulbs. If it is adopted by the railroads it will displace 48 different lamps.

The new type of lamp has many things to recommend it. As it is all-frosted it is generally suited to all types of reflectors and can be used in open type reflectors with little likelihood of causing glare. The frosting is highly efficient and throughout the life of the lamp the light absorption by the frosting is less than two per cent. As the frosting is on the inside, the outside of the lamp has a smooth glass surface that is easy to clean. The life of the lamp is about the same as those now in use, and the cost of the new lamp eventually should be a little less than the present cost of the clear type C lamp.

Adoption of the lamp will undoubtedly improve car lighting and while it is more expensive to manufacture than the clear lamp, the cost can be lowered because many different types will be replaced by a few. The reduction in numbers of different types will also effect a marked saving to the railroads by greatly reducing the number of lamps kept in stock. Such difficulties as having a clear lamp placed where a bowl frosted lamp should be used will, of course, be eliminated.

Similar lamps in the 110-volt line are now being placed on the market. The 25-watt, 110-volt lamp in the A-19 bulb is now available and the 100-watt A-23 lamp will be available in quantity in the near future. The 32 and 64-volt lamps are not yet officially listed in the schedules. Just when they will be ready will probably depend largely upon the number of requests for these lamps from the railroads.

The Electrical Convention

The sixteenth annual convention of the Association of Railway Electrical Engineers held during the last week in October at the Hotel Sherman, Chicago, was beyond question the most successful that the association has ever held. A year ago the total enrollment of railroad men at the convention was 130 against 195 this year. Year by year the association is growing in numbers and prestige. This year the number of committee reports was noticeably fewer than heretofore and there was time for adequate discussion.

Among the more important accomplishments of the association this year, was the publication of the manual on electric welding and heat treating which will be ready for distribution in a short time. The welding manual gives complete information on the subjects of electric welding of all kinds. Every kind of electric welding that has been found practical is included; others have been discarded.

A second manual which the association has brought out this year is that on the subject of illumination. There is no question but that better lighting for the great va-

riety of conditions met with in railroad operation is of major importance, and the manual of illumination goes into greatest detail in pointing out the best methods of securing the most efficient results under all circumstances.

Not alone has the Association of Railway Electrical Engineers made remarkable progress but the Railway Electrical Supply Manufacturers Association which is so closely identified with it has likewise become a strong organization. This year all of the space in the large exhibit hall was taken by 59 different exhibitors; indeed it was necessary to erect 14 booths on the mezzanine floor to accommodate all of those desiring space.

Electrical applications are so extensive and diversified that the railway electrical engineer is confronted with a difficult task in familiarizing himself with all of them and protecting the best interests of his road. This undoubtedly accounts for the rapid growth of the Association of Railway Electrical Engineers for it has sought consistently to assist its members in solving their problems and in standardizing electrical products and practices.

Buses and Bus Lighting

The service provided by the bus is usually between large cities and suburban towns or between cities that are not more than 50 miles apart. It is true that buses are also operated over much longer distances such as from Boston, Mass., to New York, or from New York to Miami, Fla., but such records as have been kept show that the longer runs include very little repeat business and do not take an appreciable amount of revenue from the railroads. The buses succeed because they render convenient service that the traveling public likes. They run more frequently than the trains, they run through more interesting country, and each passenger usually has a comfortable individual seat and is taken closer to his ultimate destination than is possible with railroad travel. Unfortunately for the railroads, the business which is taken by the buses consists for the most part of the full-fare passenger, the afternoon shopper and the theatre goer, rather than the commuter. The railroads have met some of this competition with rail motor cars and a few of them are now beginning to go into the highway bus business aggressively. It looks as if in the near future many railroads would be operating fleets of buses.

This innovation will introduce a new set of problems and new work for the electrical men, among the more important of which is lighting. The lighting in some of the buses is good, but in many it is at best mediocre and poorly distributed. It can be likened in many ways to the early stages of train lighting. At present the bus is still much of a novelty and the traveler is willing on this account to put up with such an inconvenience. As the novelty wears off, however, the traveler is going to insist on better illumination, particularly if in the meantime the bus is operating on some railroad's regular schedule. Such difficulties can often be anticipated and their solution requires the co-operation of the builder and the railroad electrical engineer, or perhaps better the car lighting man. The bus which is provided with adequate and uniform lighting will naturally be more in demand than one which is not and if the equipment is adequate and well designed to begin with, the maintainer of the lighting equipment will avoid much trouble.

Turbo-Generators With Train Control

The increasing application of automatic train control of one system or another has given rise to numerous problems, not the least of which is a supply of energy necessary for its operation. At the recent convention of the Association of Railway Electrical Engineers in Chicago, it was generally agreed that one turbo-generator on the locomotive was sufficient to supply current for both locomotive lighting and train control equipment. There was, however, a considerable divergence of opinion regarding the size of the machine necessary to perform the dual functions properly. The whole question of train control application is of such recent origin that many improvements are practically certain to be made before anything like the ultimate in this development can be reached. During this development stage the chances for the success of one system are as good as another and it is not unlikely that the requirements in the way of energy supply may be many times revised before the best solution is arrived at. In this connection the discussion of 500-watt turbo-generators versus 750-watt machines does not appear to be one which can be definitely settled one way or another at this time. Although there are many engineers who believe that the 750-watt turbo-generator set is necessary for the efficient performance in handling both locomotive lighting and train control, it is nevertheless a fact that subsequent developments may prove that the 500-watt machine is amply large to do the work or that a 750-watt machine is not large enough. The fact is that some roads are using the 500-watt machine now for that purpose and the results are satisfactory. It must be recognized that there are thousands of 500-watt machines in service and if it is possible for them to be used satisfactorily to meet both lighting and train control requirements it should be done. Certainly, it is too early to settle definitely that the 750-watt turbo-generator must be used.

Letter to the Editor

New Haven, Conn.

To the Editor:

I note statement on page 291 of your September, 1925, issue based on report of Commercial Attaché at Paris regarding Swiss railway electrification, in which it is stated that it is questionable whether conclusions heretofore generally accepted are sound and whether the plans already adopted for railway development in Switzerland should not be materially modified.

The burden of the statement is so much at variance with my observations during a visit last summer that I have taken the trouble to check the statements made, and find that there is no intention to slow down the speed at which electrification is proceeding in Switzerland. Five hundred and twenty miles are at present operated electrically and 485 miles will be electrified by the end of 1928. This 1,005 miles represents 56 per cent of the whole system mileage and carries 75 per cent of the traffic.

It is, of course, true that the economics of electrification vary with the price of coal, and it is possible that the price of coal may be so materially reduced as to eliminate the savings due to electrification, but apparently this point has not been reached. Sidney Withington,

Electrical Engineer, New York, New Haven & Hartford.

Railway Electrical Men Meet in Chicago

Sixteenth Annual Convention of the Association of Railway Electrical Engineers at the Hotel Sherman Draws Record Breaking Attendance

THE sixteenth annual convention of the Association of Railway Electrical Engineers held at the Hotel Sherman, Chicago, October 27 to 30, was the largest that the association has ever held. Not only was the attendance greater than in any preceding convention, but the amount and variety of electrical equipment on display in the exhibit hall exceeded any similar display in previous years. Fifty-nine members of the Railway Electrical Supply Manufacturers' Association more than filled the recently completed exhibit hall.

The opening session of the convention was called to order at 10 a. m., Tuesday, October 27, by the president, F. J. Hill, chief electrician, Michigan Central. In a few brief remarks Mr. Hill emphasized the importance of prompt attendance at the various meetings.

The report of the secretary-treasurer, J. A. Andreucetti, assistant electrical engineer of the Chicago Northwestern, indicated the strong financial position of the association, the report showing a balance of more than one thousand dollars over that of a year ago, or a total of $4,407.80.

Hotel Sherman, Chicago

WEDNESDAY SESSION

The second session was opened with a presentation of a report on train lighting by A. E. Voigt, car lighting engineer for the Santa Fe. Abstracts from the discussion follow:

THE PRESIDENT: "Gentlemen, you have heard the report. It is now open for discussion."

L. S. BILLAU (B. & O.): "Mr. Chairman, I should like to ask if the recommended changes in battery box dimensions have been adopted yet by the American Railway Association by their letter ballot or is that a proposition to be put up this year for consideration?"

MR. VOIGT (Santa Fe): "That was just adopted by this Association. It has never been presented, I do not think, to the American Railway Association."

THE SECRETARY: "Mr. Billau, I believe that was the recommendation of the Committee on Train Lighting last year or the year before, but the Committee at that time did not go definitely on record as recommending any specific size for battery boxes, and in order to make the matter definite this Committee now suggests that as a definite recommendation for adoption."

MR. BILLAU: "If in order I should like to offer a motion that the proposed recommended changes in size, minimum dimensions in battery boxes as covered in this report, be adopted by this Association and placed in our manual."

MR. KELLY: "I second the motion."

THE PRESIDENT: "It is moved and seconded that the recommendations of the committee on battery box dimensions be accepted. All in favor say Aye, contrary No. It is carried."

THE PRESIDENT: "We would like to hear a little further discussion on this paper if we can get it. How many roads have tried out the rubber-faced pulley?"

MR. E. MARSHALL (Gt. Nor. R.R.): "The Great Northern now have ordered some sample pulleys but we have not any of them in service yet."

MR. VOIGT: "We have tried them out, but the time has not been sufficient to give conclusive data."

MR. GARDNER (Burlington): "We are trying out one of these pulleys, but have not had it in service long enough to get any reliable data from it."

MR. E. LUNN (Pullman Co.): "One of the first expedients that I tried was to put Rabestos brake lining on the surface of the armature pulley. The Rabestos was riveted to the surface of the pulley securely, but inside of a week a copper filling was in evidence and the belt had been discarded and another belt had been applied. They were in bad order, which indicated to us that there was some slippage. A rubber belting was then riveted to the surface in similar manner and it did not last more than a few weeks until it came off.

"Then another expedient was tried, that of putting tape, friction tape, on the surface of the pulley to prevent slipping. That was very effective. The tape would last for two or three round trips between Chicago and New York and then the tape would come off, and it was necessary to apply some more."

THE SECRETARY: "Under the head of Axle Lighting Equipment the Committee suggests No. 2 cable be used on all such wires except field wires. If that is the proper thing to use, instead of making it a suggestion why not make it a recommendation and thereby nail down something definitely? These suggestions are either good or bad. If they are worthy of suggestions for the improvement and betterment of the service, they are certainly worthy of recommendation.

"Under the head of Automatic Switch, this is a little ambiguous to me, you say that you want a reliable switch. What is a reliable switch if the one we are using is not reliable? In other words, what would be the characteristics or what would be the inherent characteristics or the design of a proper switch to be reliable?

"Under Adjustments I might say the same thing. Let us bring out some definite recommendation at some future date, so that we can present them in our loose-leaf manual for a guide.

MR. VOIGT: "In regard to the automatic switch I feel that is a subject that possibly the manufacturers should be consulted on, and for us to make a definite recommendation we might ask something that is not consistent."

E. S. M. MACNAB (Can. Pac.): "I would like to hear from the members present what troubles they are actually experiencing with the automatic switch at the present time. It is more or less news to me that the present automatic switches supplied by the three more or less standard equipment manufacturers are causing any trouble. If there is something, I would like to hear about it. We have got about nine hundred equipments now and with the exception of one equipment we have had very little trouble."

THE PRESIDENT: "I do not think you understand. Nobody is complaining about the functioning of an automatic switch. What they are trying to bring home to the Committee is that they should make a definite recommendation."

MR. VOIGT: "The trouble referred to about the difficulties of

the automatic switch are largely characteristic where a road is operating switches too close to the battery voltage."

J. R. SLOAN (Penna. R.R.): "It appears to me in the light of what has gone before that possibly it might be an advantage to have the Committee instructed to clean up the work of the Committee on specifications for some years past and prepare a definite specification and test to be sure that the specification is met."

THE PRESIDENT: "In other words, your recommendation would be to revise the specification?"

MR. SLOAN: "Yes."

THE PRESIDENT: "I think you are right. Do you want to make that as a motion?"

MR. SLOAN: "Set down what the switch ought to perform and then set down the tests which they should make in order to know that it does perform. I make that as a motion."

THE SECRETARY: "I second the motion."

THE PRESIDENT: "Motion is made by Mr. Sloan, seconded by Mr. Andreucetti. You have heard the motion. All in favor of the motion signify it by saying Aye, contrary, No. It is carried."

MR. SLOAN: "Mr. Chairman, under this Axle Lighting Equipment it mentioned the method in which the battery connectors are connected to the battery terminals. There is quite a number of methods of performing that job. I would suggest that the Committee take in all the different types and try to determine which is the best method of making that connection."

THE PRESIDENT: "I agree with you, Mr. Sloan, but in view of the fact that we have asked this Committee to go back and review the specification I see no reason why they cannot cover all the items that they have got in their report here and make a definite recommendation on each one of the items mentioned."

MR. YOUNG (Big 4): "Along the line of connecting the batteries with the main line of the car. On the Big Four Railroad we have never found that necessary. We solder our battery connector to the line of our car."

MR. VOIGT: "This report deals largely with the individual connection between cells. Of course, no doubt, soldering or welding of the connection to the car would be advisable. I might call attention to the recommendation, that No. 2 cable be used between the dynamo, battery and the regulator on all wires except the field."

MR. YOUNG: "I would like to ask the Chairman if that takes in all classes of the equipment and also all conditions that exist on cars. We find on our road that a lot of our cars have a run of not over twenty feet between the three points of the equipment, and I believe that it would work a hardship on roads to make them come to a No. 2 cable when a smaller sized line could be used without any line loss on the car."

MR. VOIGT: "I might say that these are just recommended practices and we cannot cover of course all the individual cases. Recommended practice does not necessarily mean that you absolutely have to follow it."

MR. BILLAU: "Mr. Chairman, the underlying reason, as I see it, for recommending this larger size of cable is to reduce to a minimum the voltage drop between the battery and the lamps."

MR. GARDENER: "It looks to me as if we might want to recommend different sizes of cable for different capacities of machines. I don't quite see why we should need the same sized cable for the small generator that we would for the large ampere generator. I think Mr. Billau's idea that the size of the cable could be determined possibly by the voltage drop would be a better proposition than having the same sized cable for all capacities of machine."

THE SECRETARY: "That leaves you just where you are now. That is what we are trying to get away from."

MR. VOIGT: "This recommendation possibly could have been put up in different form in regard to certain percentage drop, but we would have to make an investigation before we could specify the percentage drop."

MR. SLOAN: "Mr. Chairman, it occurs to me this whole question is one which does not in any way affect interchange. It is the road's own troubles to put that size of wire on. The only logical way to do it that I can see is to figure out what percentage of voltage drop you can stand for and then use the size of wire accordingly."

THE PRESIDENT: "That is correct. I do not think there is any use of discussing that question any further. Mr. Voigt is chairman of this Committee and it will be well for car-lighting men to treat that committee as a clearing house. If anything comes to your mind refer your question either direct to Mr. Voigt, as chairman of that committee, or to the Secretary-Treasurer of our Association. Lots of times when you get home you think of a few things that ought to have been brought up here when you were discussing the paper. We would like to hear somebody on suburban coach lighting as to the progress that has been made. Are there any members here who are using turbo-generators for suburban train lighting?"

P. J. CALLAHAN (B. & M. R.R.): "We are using them on light suburban trains, but we are not any further advanced in the application than we were last year. The operation has proved very successful. We are operating one eleven-car train and one eight-car train, but we have not been able to go ahead. We do expect to produce a tentative program whereby we will equip all our suburban cars with the head-end lighting."

THE PRESIDENT: "Will you be able to give this Committee something for next year's report?"

MR. CALLAHAN: "I hope to. There is something else in connection with that. For the purpose of providing against an engine failure we have provided a battery. We install a 52-cell Edison battery. Our equipment is a 64-volt and we install a 64-volt automatic switch on the locomotive. The battery is in circuit all the while, and on one particular occasion the battery was able to take care of an excursion train about an hour and a half or two hours on discharge and bring the train in OK without any turbo on the engine. Our experience has proved in short suburban service it is hardly necessary to provide that. The expense is quite great and we do not feel, except perhaps in isolated branch-line service, that there is any great necessity for providing auxiliary lighting."

A. J. FARRELLY (C. & N. W. Ry.): "We have three trains lighted by turbos using the double voltage, 64, on the train and 32 on the headlight. One of these trains is a very particular train. It has been running eight or nine years. Aside from little troubles that you have on any system we do not hear of the lighting at all."

A. E. GANZERT (Rock Island): "Last year we changed to head-end suburban lighting. We now have everything running out of Chicago head-end lighting. We are running a 7½ kw. Pyle type M."

MR. GARDNER: "On the Burlington we electric-lighted all of our Chicago suburban trains about fifteen years ago with turbines on the locomotive. We have never used any batteries and there has been practically no complaint on this lighting. I do not think that for such a short run we would want to recommend the use of a battery unless the train has to stand in the station without the locomotive attached to it."

THE PRESIDENT: "Mr. Gardner, will you be good enough to tell us how you take care of the lighting of those cars for night cleaning?"

MR. GARDNER: "We do most of our cleaning in the daytime."

THE PRESIDENT: "What is your answer to that, Mr. Ganzert?"

MR. GANZERT: "For our night cleaning we have installed a generator set. For head-end service they are connected in two circuit series of 64-volts, connected automatically, and for emergency lighting we use one circuit on a 32-volt battery. We started out with cleaning cars at night. We used the batteries and found that the next morning we did not have anything left in the batteries. The next step was to put a switch in the battery circuit so that when the engine is cut off the train the battery circuit is opened. The next step after that was to put a motor generator set in for train lighting, giving 64-volts for night cleaning. I think the Illinois Central ought to tell us what they are going to do on their suburban train lighting."

THE SECRETARY: "Is there anybody here who is familiar with the Illinois Central method?"

MR. P. S. WESTCOTT (Pyle Nat. Co.): Mr. President, I have only heard the talk. This of course is not authoritative but, as I understand it, the Illinois Central are running their electrical equipment in two cars, the motor car and trailer. When you make up your train it is a multiple of two cars. On that basis, as I understand it, also, they are using a motor generator to supply the current for these two cars. The motors operate off the trolley voltage and the generator furnishes the light at 32 volts. Other than that I cannot say what it is, but I believe that is correct."

MR. LIVINGSTON (Safety Car Heating & Lighting Co.): "I think I can give a little information on this because the Safety regulator happens to be used with the General Electric motor generator set on these cars. The motor generator set supplies light for both the cars. There is a generator regulator and a lamp regulator in the motor car that regulates the charge to the battery from the generator. There is another lamp regulator

for the trailer car to control the lamp voltage in the trailer. The output of the motor generator set is 3 kw. and varies in speed from 800 r.p.m. to about 1,600 r.p.m. depending on how the line voltage is, whether it is down to 700 or up to 1,600. The motor generator set was designed by the General Electric Company and through co-operation with the Safety Company the regulation was supplied and the two worked together very well. There is no jumping of the lights or surges in the battery when this motor generator set throws directly 1,500 volts on the line."

Mr. Sloan: "Mr. Chairman, I move that this report be referred back to the Committee with instructions to present definite recommendations in their report, with the exception of the battery box dimension.

The Secretary: "I second the motion." *Motion carried.*

The second report presented was that of the Sponsor Committee on Wires and Cables. There was no discussion on this report which was accepted and the committee continued.

The final report presented at the Wednesday session was that of the Committee on Power Plants. This report was read by J. E. Kilker. The discussion was opened by Mr. Sloan who spoke as follows:

"Mr. Chairman, at the top of the second column the statement is made: 'Each plant must be laid out and designed for the facilities it is to accommodate. Efficient equipment which will produce the most economical operating condition should be selected.'

"I think that ought to be changed a little. The most economical financial operating condition is what we are looking for, because we can spend money to effect economy in operation and we will lose out in the long run on fixed charges and maintenance."

Mr. Gardner: "Mr. Chairman, I want to say something on what we have been doing on the Burlington the last two or three years. It does not quite agree with the report of the Committee. At the same time, we have been checking up our operating costs very carefully and I feel very sure that we are on the right track. At a number of our small points we have been able to electrify certain steam equipment and thereby shut our boiler plant down entirely in the summertime. In doing that we have made appreciable savings."

Mr. Marshall: "Mr. Chairman, in regard to being able to shut down steam plants in the summertime by the purchase of electric power, there are a great many of these roundhouse points that would be able to shut down their steam plant in the summertime if they could obtain power to operate air compressors and other facilities."

Mr. Billau: "Mr. Chairman, the point brought out by Mr. Marshall as to the means whereby steam plants may be shut down in the summer months, at least in some cases, and almost permanently in other cases, as far as high-pressure boilers are concerned, covers two features. One of them is the generation of compressed air and I think all are more or less agreed that the electrically driven air compressor has been perfected to the point where it is very successful, even in the small sizes as well as the larger, and the other question is the drafting of locomotives. The Baltimore & Ohio has experimented quite extensively with a portable electrically driven fan for drafting locomotives, also for ventilating boilers when the men are working in them. At the present time this experimental installation has been in service for a number of months and its application to other small roundhouse plants is being actively considered."

Mr. Moring (Sou. Pac.): "Do I understand that the boilers are washed with cold water?"

J. C. McElree (Mo. Pac.): "On the Missouri Pacific Railroad we have boiler-washing plants at most of the roundhouses, and where boilers are washed it is necessary, we think, to use hot water and we use it. In such cases it is not possible to entirely eliminate the steam plant, either during the summer or the winter."

Mr. Farrelly: "The North Western just now is changing over from power plant operation to the purchase of current, but we are still maintaining steam for the heating of water for boiler washing."

The President: "Mr. Kilker, has your Committee heard anything on the drafting of locomotive boilers by a fan?"

Mr. Kilker: "I have in a general way. Several attempts have been made for developing a fan placed over the locomotive stack for furnishing the draft. I do not know just to what extent the development has progressed, but I believe that if a proper device is developed that it will unquestionably save power over the present method of blowing by steam."

Mr. Marshall: "The Great Northern is now experimenting on the use of blowers for this purpose, expecting to install an individual fan at every stack in the roundhouse. Tests that we have made on one single stack installation show that the cost of firing up in kilowatt hours is 3½ from cold water to 110 pounds of steam."

The President: "That would be put in as an addition to your present power plant? You would not cut out your boilers of course?"

Mr. Marshall: "No, unfortunately we are situated there so that we require steam for other purposes. However, this drafting of locomotives, I think when that is solved, we will be able to eliminate a large number of small stationary power plants at other points."

Mr. Gordon (Can. Nat'l Rys.): "On the Canadian National Railways we have been closing down some of our steam plants during the summer months and using electrical energy for the purposes named. We have had very good results from that and have brought about considerable economies."

Mr. McElree: "I would like to know whether they use hot water for washing boilers on the Canadian National Railway at places where they are closing down their stationary plants and if so how do they produce the hot water?"

Mr. Gordon: "We use cold water."

Mr. Gardner: "Where we close down the plants in the summertime we utilize the incoming locomotives to heat the water for washing out boilers."

Mr. Kilker: "I would like to ask Mr. Gardner what temperatures he is able to maintain the wash water at where he uses the electrical draft pumps where there are only a few engines to handle."

Mr. Gardner: "In answer to this question I would say that our old practice was to install an underground sump, and the steam from the locomotive that is going to be washed out was blown into that sump to heat the water and also in fairly good districts the water from that locomotive is largely blown in."

Mr. Kilker: "Do I understand that the same water is used in filling up the engine that is blown off from the engine?"

Mr. Gardner: "In certain cases, yes, with the addition, of course, of fresh water."

George W. Bebout (B. & O. R.R.): "I think it is very bad practice to wash boilers with cold water. We had at one time quite an epidemic of cracked boxes and flue sheets on account of washing with cold water. I want to say a word in defense of the old locomotive boiler, not that I recommend its installation. There are so many economies that can be effected in a power plant that we ought to be looking out for them all the time. We have been installing some stokers on boilers as low as 200 horsepower that have proved to be efficient and we got better results from steam by keeping the pressure where it should be, and we have saved quite a lot of fuel and labor. Usually you can make pretty good economy with stokers on a smaller boiler. In one plant we are saving over $2,000 a month on the operation of five boilers."

C. G. Winslow (M. C. R.R.): "One trouble with our whole power plant situation is that we do not know how much steam we are making for the coal that we put into it. I think one of the best paying investments that you can make is a measuring instrument that will tell you the amount of water you put into that boiler. You know the amount of coal because you weigh it. Then you have a record and you can get a continuous record which you have not now."

The President: "Are there any further remarks? If not, a motion is in order to accept this report."

Mr. Sloan: "I make that motion, Mr. Chairman."

Mr. Billau: "I second the motion." *Motion carried.*

THURSDAY SESSION

The first report of the Thursday session was presented by L. F. Miller, formerly road foreman electrician of the Chesapeake & Ohio and now with the Industrial Controller Company. The subject was the Safe Installation and Maintenance of Electrical Equipment. The discussion was opened by Mr. Andreucetti, who spoke as follows:

"This paper contains many good recommendations. There may be members here who may not agree with some of the recommendations of the Committee. Let us have a full discussion on any of these features. It is proposed that such recommendations as are included in this report which would be of tangible benefit be incorporated in the loose-leaf manual under this heading, and the Chairman of the Loose-Leaf Manual Commitee will take this

report after this meeting and extract from it such recommendations as his Committee and the Executive Committee feel should be included in the manual."

L. D. Moore (Mo. Pac.): "Mr. President, in connection with the last recommendation regarding resuscitation, the Committee report recommends that the Chairman and others acquaint themselves with this method and that they be encouraged to practice it. I am a great believer in the matter of resuscitation because I have known of a number of cases where it was very effective. It would be my suggestion that the manual at least include as recommended practice that regular drills by the electrical force in artificial resuscitation be held. I will make that motion."

Mr. Minick: "I want to second that motion." *Motion carried.*

Mr. Johnson (New Haven): "Referring to paragraph 7, I believe limiting the number of lamps on a circuit will increase the cost. This seems to me an increase in the wiring cost and necessarily we cannot approve of it. Now, in regard to the three-phase proposition for 100 amperes the same thing applies."

Mr. Sloan: "The report states that in all cases the National Board of Fire Underwriters' rules shall be followed. Those rules cover that section in which they prescribe practically the watts that are allowed on a circuit. I think that should take precedence of section 7 as it is written."

Mr. Minick: "Mr. Chairman, I think if you read the code rules very carefully you will find that the code has established two limits. They have established first a wattage limit per circuit; second, they have established a fuse size for the circuit and they have also established an alternative standard of the number of outlets per circuit, and as between the wattage and the number of outlets that one which approaches most closely to the fuse size is the one you must use. I am very much inclined to favor the code rule not because it may be any better, but it is an established rule and is well-known all over the country. Everybody is following it at the present time."

Mr. Sloan: "I move that section 7 under wiring be stricken from the report."

Mr. Johnson: "I second the motion." *Motion carried.*

Mr. Moore: "Mr. Chairman, with respect to No. 8, particularly that part of it referring to circuits of 100 amperes capacity being three phase, I think that depends a lot on your local conditions."

Mr. Minick: "Mr. Chairman, I agree with the statement that has just been made as to the three-phase situation. I think when you get to straight lighting circuits that you can very safely stick to the single phase service."

Mr. Gardner: "Mr. Chairman, this last sentence in paragraph 8 'Where the load exceeds 100 amperes, it is recommended that a three phase system be used.' I am not absolutely in agreement with that sentence. I think it is much simpler to use single phase on your lighting, balancing up the load the best you can."

Mr. Minick: "Mr. Chairman, the fifth paragraph under Installation states, and this refers to the grounding:

"If a cold water pipe is not available, it is recommended that a ground connection be made by driving not less than a three-quarter-inch galvanized pipe, or its equivalent, in the ground a sufficient depth to insure a permanent ground.'

"I do not feel that this Association should make that character of recommendation. If you drive a three-quarter-inch pipe into the ground it may be a very good ground at the time you make the installation, but it is reasonably certain that within a short period of time it does not amount to very much as a ground. A galvanized iron pipe corrodes through very quickly. Any kind of wrought metal, sheet brass, sheet copper, or anything of that kind, will corrode very rapidly and within a reasonable time will be entirely destroyed as a ground connection."

Mr. Ganzert: "Our practice on the Rock Island for safety grounds and lighting circuit grounds, is that any ground that will be sufficient to blow a three ampere fuse on 110 volts is used. The practice is to test the grounds twice a year, spring and fall."

Mr. Johnson: "I think the subject of grounding ought to be taken up and carefully studied because it is liable to bring out dangerous conditions."

The President: "What is your practice, Mr. Winslow?"

Mr. Winslow: "I have investigated the method of making grounds considerably, and it is my opinion, and that of others, that a half-inch rod or three-quarter-inch solid rod, perhaps ten feet long, gives you the best and most durable ground that we can find. If you need a ground of larger capacity, drive additional rods, but space them from four to five feet apart, as many as you care for, and then connect the top with heavy copper."

The Secretary: "Mr. Minick, don't you think it would be well to change that part of it referring to a piece of pipe to a rod, as Mr. Winslow suggests?"

Mr. Minick: "Yes, I think that might be better. That sentence reads: 'If a cold water pipe is not available, it is recommended that a ground connection be made by driving not less than a three-quarter-inch galvanized pipe, or its equivalent, in the ground a sufficient depth to insure a permanent ground.' My recommendation is that that be changed from a three-quarter-inch pipe to a three-quarter-inch solid iron rod or larger, and that a further statement be added to the effect that if such grounds are used they shall be inspected at frequent intervals and if found defective shall be renewed."

Mr. Winslow: "My suggestion was to make it a half-inch rod instead of a three-quarter-inch rod."

Mr. Minick: "Make it a one-half-inch or larger."

Mr. Ganzert: "I would like to hear from somebody to see how they test their grounds or what means they use to determine whether they have a real ground. I checked sixteen ground connections not long ago and found we only had three real grounds out of the sixteen."

Mr. Moore: "With reference to the gentleman's question as to the method of testing ground, it seems to me something of that sort should be included in this manual. The matter of testing grounds I think is something that is not generally understood. It might be well to put a paragraph in there describing the proper method."

Mr. Minick: "I am going to touch upon the character of the connection you provide between your wiring system and your ground connection. The Underwriters' Code provides for the metallic clamp, for instance, to be placed around the conduit and the limiting measure of which is the current value of 200 amperes per square inch of contact surface. As railroad people are going to be compelled very shortly to ground piping up to possible six or eight inches in diameter, by reason of some of the codes now being adopted by some of the other associations interested in railroad work. A little thin copper ribbon three-quarters of an inch to one inch wide going around an iron pipe only once, held together by single bolt or screw, probably a quarter of an inch in diameter, does not make an effective ground for current values of considerable magnitude. It seems to me this is a subject that the Committee could very readily look into for next year's report. I wish to make a motion that the matter of ground clamps, together with the matter of proper method of testing ground connections shall be referred to the Committee for consideration in their next year's report."

The Secretary: "I second the motion." *Motion carried.*

Mr. Sloan: "Mr. Chairman, if you are through with that subject I would like to take up No. 9 at the top of page 309. No. 9, reads, 'The use of fuses for the protection of motors is not recommended.' I move that that be changed by saying that the use of fuses for the protection of motors is condemned."

Mr. Minick: "Mr. President, it seems to me that there is involved in this motion, paragraph 8 at the top of page 309, first column. 'Fuses are not recommended where automatic circuit breakers can be used.' My feeling is very much like Mr. Sloan's that fuses ought not to be used in power circuits, and it seems to me that if we take out one of those paragraphs the other paragraph will have to be modified accordingly."

Mr. Gardner: "Mr. Chairman, I agree in a general way with the proposition that fuses should not be used on power circuits. On the other hand, we use them on practically every power circuit for the reason that we will put on an automatic compensator with overload relays ahead of the motor, and we put the money into that and then we will put fuses on to protect the wire, making them big enough so that the overload relays will protect the motor but the fuse will protect the wire."

Mr. Miller: "I would like to say that the Committee did not make that quite as plain as they should in this case. We should have brought out the point that we did not mean on the start overload relays or circuit breakers should be used. That is entirely optional. This Committee feels that the use of fuses on the starting side is entirely adequate to protect the wire and any change at all that you might see fit to clarify that will be absolutely agreeable."

Mr. Minick: "Mr. Chairman, paragraph 6 at the bottom of the first column on page 309 says: 'The installation of extra high potential circuits is adequately covered by the Code.' I am not just sure about that. The Code is primarily to cover service

up to and including approximately 600 volts. They have not touched upon high tension equipment of any character above 600 volts except where they have been by local conditions forced to do so."

Mr. Winslow: "I assume by the Code you mean the National Electric Code."

Mr. Miller: "And also the Safety Code."

Mr. Winslow: "The Safety Code in a great many ways covers high potential installations. Was that your idea?"

Mr. Minick: "Mr. Chairman, I may be working at cross purposes here. I simply assumed that that meant the National Electric Code. The National Safety Code I know does touch upon that subject more fully than the Underwriters' Code."

Mr. Miller: "Mr. Chairman, in going into this particular question we did not deem it advisable to go into the high tension part of the work because we have so little of it on the railroads where our own men do really go into the question that we did not think it would be necessary to go into a lengthy report covering high tension apparatus, and where we referred to the word 'Code' we did not only mean the National Electrical Code as laid down by the National Board of Fire Underwriters but also the book which we had previously referred to which is secured from the Superintendent of Documents in Washington and is a National Safety Code, and that does cover very adequately the insulation of high tension apparatus."

Mr. Sloan: "Mr. Chairman, it might meet the situation to leave the Sixth paragraph as it is and in place of the word 'Code' put in the 'National Electric Safety Code.' I move that Section 6 shall read, 'The installation of extra high potential circuits is adequately covered by the National Safety Code.'" *Motion carried.*

E. Lunn: "Mr. Chairman, I do not know whether the question I am going to ask belongs here or in some other report, but it appears nothing has been said about equipment in storage battery rooms covering the wiring and construction of the parts of the room and the protection of the apparatus in the battery room, especially in rooms in which lead batteries are cleaned. I have in mind the question of the installation of the circuits. If circuits are installed in conduit it is bad practice, because conduits are soon eaten away by the action of the acid. If installed in the open it is equally bad practice. The question is then what should be done? Is it proper to discuss that at this time? I bring it up only for the purpose of having the question handled in the proper place."

The President: "I would say it was covered."

Mr. Lunn: "Then I wish possibly to take some exceptions to it to this effect, that it has been found that the proper way to install circuits in the battery room is to install them in a wood trough with a screwed cover without any other protection except the wood trough supported from the ceiling. The wood trough is to be covered with a covering of sheet lead which extends down the sides of the trough a half an inch or inch below the bottom. Acid cannot get at the wires which are led out through the bottom through porcelain or rubber bushings, and there is no danger of fire."

The Secretary: "Mr. Chairman, I suggest that the Committee next year take up the question of wiring in battery rooms as outlined by Mr. Lunn with the view of making some recommendation."

The report on Illumination was next presented by Mr. Billau who spoke as follows:

"In view of the fact that this report covers two or three branches of the subject, I will take up each part of the report separately.

"The first section of the report covers changes in train lighting lamps. Since this report went to press the lamp industry has brought to the attention of the railroads their proposed new line of train-lighting lamps. As a consequence some of the recommendations made in the report as submitted are subject to change. The new line of lamps is offered at this time tentatively to the railroads for their consideration and criticism and is offered as an additional line to the present standard line with the expectation that gradually the change over will be made to the newer types and the older types will disappear.

"Before discussing the new line of lamps, I wish to bring up a few points of the present recommended standard lamps. In this connection the first recommendation I make is that the 15-watt, S-17 bulb, train-lighting lamps adopted by the Association to meet the general requirements of train-lighting service as given in Table No. 3 in the 1924 report be dropped and that this table as revised be placed in the manual of the Association in the Train-Lighting Section. Of course, it is understood that any of these existing lamps, such as the S-17 bulb, will continue to be available for use as long as the railroads may require it, but it is the purpose, of course, to eliminate from the table of recommended lamps those lamps that we expect to see discontinued.

"A motion will be in order then to cover this first recommendation of dropping the 15-watt, S-17 bulb lamp from this recommended list."

Mr. C. R. Gilman (C. M. & St. P.): "I make that motion."

The President: "Do you all understand this now?"

Mr. Gilman: "I would like to have that include the 64-volts also."

Mr. Billau: "I will include that."

Mr. Townsend (Santa Fe): "May I ask the reason for dropping the 15-watt lamp? Is there any special advantage in dropping it? That is, the 15-watt lamp in the S-17 bulb size."

Mr. Moring: "I would like to ask all of the members present if they know of any reason at all why this S-17 should not be dropped, if there is anyone who uses that lamp and cannot use some substitute in place of it?"

Mr. Billau: "You may recall last year this Association went on record and adopted one voltage in the 30-volt range and one in the 60-volt range as standard in place of the entire range from 30 to 34 and 60 to 65. I would like to make the suggestion that we revise our list to cover in the 30-34-volt range, which now covers only one voltage, and that two voltages be recommended, 32 volts and 34 volts. We can entertain a motion to that effect."

Mr. Voigt: "I move that two voltages be recommended."

Mr. Minick: "I am wondering whether in case 32 and 34 volt be adopted as the standard it may not leave a gap in between there that will be a little difficult to overcome."

Mr. Billau: "Last year when the question was presented to the Illumination Committee the lamp industry requested that it would be desirable to work towards one voltage, and the Association so went on record."

Mr. Bebout: "When we changed from the Type B lamps to the Type C lamps, we felt that it greatly improved our illumination and that we were justified in going to the 34-volt lamp. We got a greater light and we believe it paid us to do it. We are getting much better service and longer life."

The President: "Do you burn that 34-volt lamp on a 32-volt circuit?"

Mr. Bebout: "We have some of the equipment on higher voltage. We have some that are working on a 30-volt circuit."

Mr. Billau: "It is my understanding that the recommendations we may make do not in any way prevent a railroad obtaining one of these other odd voltages."

The President: "Will you repeat your motion, Mr. Billau?"

Mr. Billau: "The motion is to the effect that the recommended list of lamps and voltages as adopted in 1924 be amended to include in addition to the 32-volt lamp only, 32-volt and 34-volt lamps in that range, and in the 60-65-volt range which now covers only the 64-volt lamp, to let that remain as the single voltage of 64 volts." *Motion carried.*

Mr. Billau: "I will read a communication received from the lamp industry just shortly before the convention."

October 23, 1925.

Committee on Illumination, Association of Railway Electrical Engineers.

Gentlemen:—You are, we believe, interested in knowing as far in advance as possible of any developments or proposed changes in the standard lines of Mazda lamps. We wish, therefore, to bring to your attention at this time developments which promise quite radical improvements in lamp designs and plans which we have under way to improve and simplify our standard lines of lamps.

For the past several years we have steadily added new types of lamps to our standard schedules, a procedure quite at variance with the progress toward standardization which has been made in other respects, as for example, in the standardization of lamp bases and sockets, and one which has gradually created an apparently unnecessary diversification. To cite one example, the 25-watt 115-volt lamp is now listed in four bulb sizes, S-17, G-18½, P-19 and G-25, collectively embodying two filament constructions, straight and coiled; and each furnished in three finishes, clear, bowl frosted and all frosted, or in other words a total of twelve varieties of 25-watt lamp.

The resources of our development laboratories have for some time past been directed toward the perfection of a design which

would combine in one type the principal advantages of each of these various types and with them other progressive improvements. This work has resulted in the development of a new type of lamp which was placed on the market about August first of this year, namely the 25-watt in the A-19 bulb with inside frost.

It is planned to extend this development as fast as production facilities will permit, and other sizes of lamps will be introduced until we have available a complete line of lamps in the new bulbs in the 115-volt range up to and including the 100-watt size.

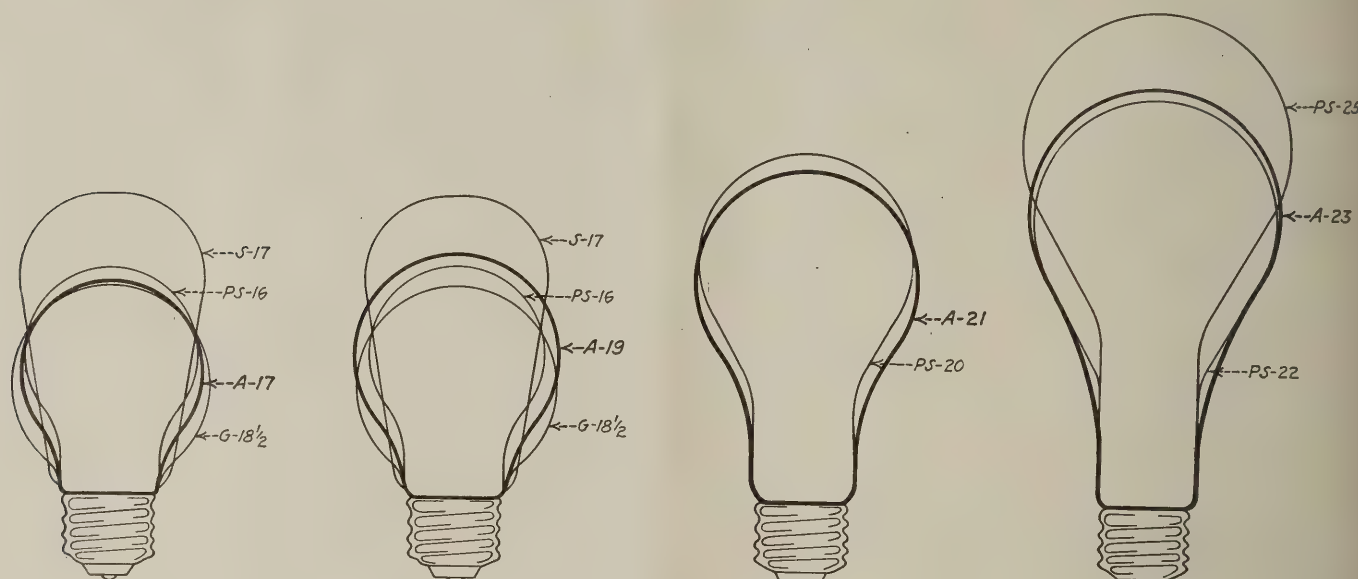
We are hopeful that through the advantage to all concerned in the use of these lamps they will largely replace all of the existing types within the range mentioned thus effecting a material reduction in the number of standard types. This program of simplification we believe to be of great economic advantage. It is directly in line with the policy of the Department of Commerce under whose direction many branches of industry have already taken similar action. As the Secretary of Commerce has justly and effectively pointed out the manufacture and distribution of an unnecessarily large assortment of any manufactured article is an economic waste.

It would seem that the present standard line of train lighting lamps offers the same opportunity for simplification as has already been undertaken in the lamps for general lighting service. We, therefore, propose for your consideration a new line of train lighting lamps as listed on the attached sheet.

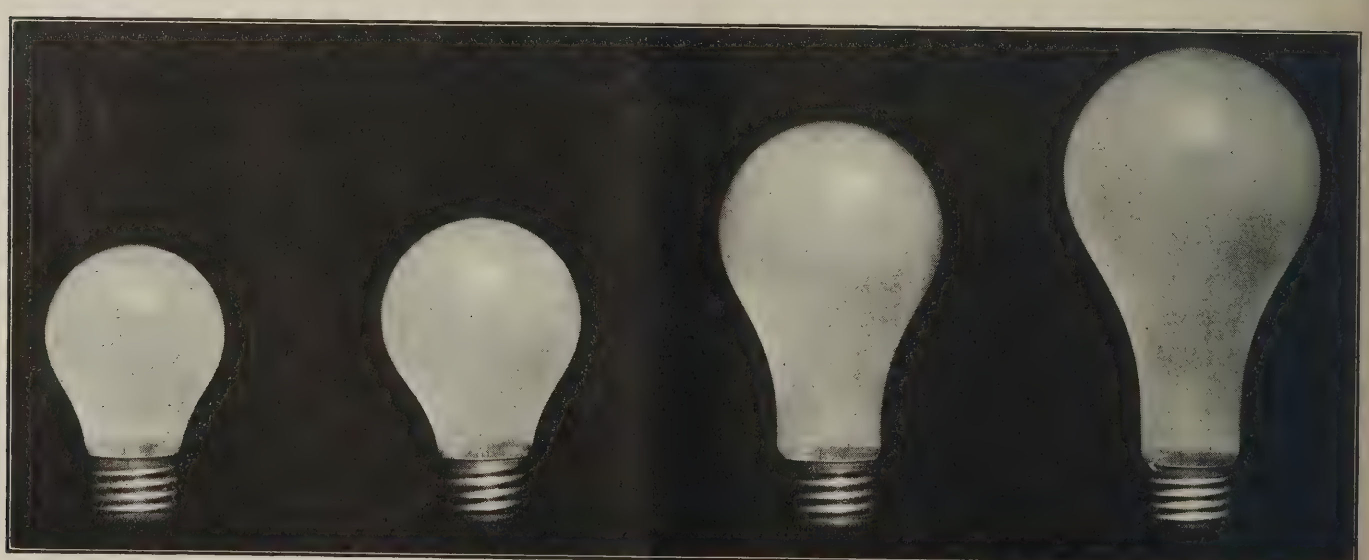
These lamps will all be in the new A type bulb which has a pleasing contour. It is frosted on the inside, which provides a means of diffusion better than any possible up to the present time. The light absorption of the inside frosting is very low, only one to two per cent. From the standpoint of ease of cleaning it is of course the equal of a clear lamp. The candlepower maintenance during life is equal to the clear lamp and superior to that of any outside frosted or coated lamp.

All of the new train lighting lamps will be of the Mazda C (gas filled) construction. The efficiencies will be approximately equal to the present Mazda C lamps and of course materially better than the corresponding sizes of Mazda B (vacuum) lamps.

We hope that this new line of train lighting lamps will meet with the general approval of the railroads as its adoption will mean the replacement of 48 varieties in the present line with 10 lamps of the new line.



Comparison of Bulbs of Various Sizes of Present and Proposed Lines of Train Lighting Lamps—The Heavy Outline Shows the Contour of the new Line



Photographic Reproduction of the New Lamps as Shown Above in Outline

A. L. Broe,
Edison Lamp Works
of General Electric Company.

H. H. Helmbright,
National Lamp Works
of General Electric Company.

Mr. Billau: "It is my understanding that the lamp industry proposes to offer these lamps as a new line which will not automatically or immediately mean the dropping out of the other

lamps. They will continue to be available as long as railroads find an imperative use for any of those particular types."

Mr. Minick: "Mr. Chairman, I should like to make one suggestion and that is that the matter of a new 75-watt lamp held I do not see any reason why the railroads should not go along with them."

Mr. Marshall: "They are probably all willing to do so, but I don't believe that we can get along without the 75-watt size."

PROPOSED NEW TRAIN LIGHTING LINE

Proposed Line					Replaces				
Watts	Bulb	Light Centre length	Max. Overall length	Diam.		Bulb	Light Centre length	Max. Overall length	Diam.
				30-34-Volt Range					
15	A-17	2 7/16"	3⅝"	2⅛"	15	S-17	3"	4⅝"	2⅛"
						G-18½	2 3/16"	3 9/16"	2 5/16"
						PS-16	2⅝"	3 13/16"	2"
25	A-19	2 9/16"	3 15/16"	2⅜"	25	S-17	3"	4⅝"	2⅛"
						S-18½	2 3/16"	3 9/16"	2 5/16"
						PS-16	2⅝"	3 13/16"	2"
50	A-21	3 9/16"	5"	2⅝"	50	PS-20	3¾"	5 3/16"	2½"
100	A-23	4 7/16"	6 1/16"	2⅞"	75	PS-22	4 5/16"	5 ⅞"	2¾"
					100	PS-25	5 3/16"	6 15/16"	3⅛"
				60-65-Volt Range					
15	A-17	2 7/16"	3 ⅝"	2⅛"	15	S-17	3"	4⅝"	2⅛"
						G-18½	2 3/16"	3 9/16"	2 5/16"
25	A-19	2 9/16"	3 15/16"	2⅜"	25	S-17	3"	4⅝"	2⅛"
						G-18½	2 3/16"	3 9/16"	2 5/16"
50	A-21	3 9/16"	5"	2⅝"	50	PS-20	3¾"	5 3/16"	2½"
100	A-23	4 7/16"	6 1/16"	2⅞"	75	PS-22	4 5/16"	5 ⅞"	2¾"
					100	PS-25	5 3/16"	6 15/16"	3⅛"

over for further consideration by the manufacturers for the reason that a considerable number of 75-watt lamps are now in use. To my mind it is rather doubtful whether a 100-watt lamp as is proposed can be substituted because of generator and battery capacity rather than lighting equipment capacity."

Mr. Voigt: "Mr. Chairman, in further connection with these lamp sizes, while I have not had an opportunity to make an actual check I do not believe that any of the recommended sizes can be used in some of the berth fixtures. Possibly Mr. Lunn can say definitely in regard to whether that sized bulb can be used in berth fixtures."

The Four Lamps at the Top Constitute the New Line—The Others on the Board Are Those Which Will Be Eventually Replaced

Mr. Lunn: "The A lamp is only a trifle less than 3/16 of an inch longer than the G-18½ which can be used in berth-lighting fixtures. I don't recall that we have any fixture that the new lamp would not fit in."

Mr. Voigt: "I might ask Mr. Lunn in regard to the upper-berth fixtures. Have you checked that?"

Mr. Lunn: "I think it would fit in there without any trouble at all."

Mr. Billau: "With reference to this question brought up about 75-watt lamps, that has been discussed with the representatives of the lamp industry to some extent. It is felt that what has been offered represents the irreducible minimum that will cover the field."

Mr. Marshall: "Inasmuch as all the 50 and 100-watt and 75-watt lamps are mainly used inside of glass fixtures, what is the use of the inside bowl frosted lamp at all?"

The President: "The idea is to clear the field on the clear lamp. Why perpetuate all these standards? The Government has asked us to do something.

The President: "We are just going to have a rising vote on this. All those who feel that they should have a 75-watt lamp please rise. I guess the 75-watters have it."

Mr. Johnson: "Can you tell the amount of absorption in this frosted lamp as compared to the clear lamp?"

Mr. Billau: "The data that I received from the lamp representatives varies from one to two per cent. The absorption is much less than with any other type of frosted lamp that they have heretofore brought out. In view of the lateness of the hour it might not be pertinent to devote much time to the very important subject of lamps for the headlighting service. That will come up for more or less discussion again before the headlighting committee tomorrow.

"I will just leave this word with you. As you know the S-14 bulb and S-17 bulb cab lamp has been under discussion for two or three years. The opinion is gradually crystallizing on it and some of you I know are aware of the fact, possibly others are not, that the Mechanical Division of the American Railway Association has now sent out a questionnaire officially through their regular channels to all the railroads of the country relative to their use. I presume that the Association itself will have some very complete information as to the railroads pertaining to its use by the time their report is presented in June.

"The last section of the report really covers the largest part of the work of the Committee during the past year, and that is the completion of this proposed lighting manual. The information contained in the manual is largely data, recommendations, etc. It is probably not worth while to take the time to discuss the subject matter in detail unless there are some particular points that you would like to bring out. I would like to mention this feature regarding the proposed manual. As you know, the first two sections were prepared last year. There are three presented here and there were two* that could not be completed in time to be included in the manual but will be presented in the *Railway Electrical Engineer* for the coming issue as supplementing the report, so that it gives all an opportunity to see this proposed lighting manual before it is finally revised and issued in the loose leaf manual of the Association.

"If there are any points that you would like to bring out in connection with this section I would be glad to discuss them at this time."

The President: "Are there any other questions you would like to ask Mr. Billau before he closes this paper? If not, the report will have to be acted upon."

The Secretary: "Mr. Chairman, I move the report be accepted and the Committee continued."

*See page 349, this issue *Railway Electrical Engineer*.

Mr. Farrelly: "I second the motion." *Motion carried.*

The next report was that of the Committee on Self-Propelled Vehicles. In the absence of all of the committee members, the report was read by Mr. Andreucetti.

The Secretary: "This report† will be published in the next issue of the *Railway Electrical Engineer* and will be included in the proceedings as a regular report. This is intended as a progress report. At this time if there are any comments to make on the report or any suggestions to the Committee for their guidance and information in carrying on this work for the coming year, they will be gladly received."

Mr. Billau: "I would like to make a suggestion that the Committee in the next year's work give active consideration to development toward standardization certain accessories of motor car work, such as lighting, etc. The present practice seems to be to give standards of lighting that are considerably below those that have been developed for the standard steam car service."

Mr. MacNab: "I understood this Committee covers the question of battery trucks; tractors and such work as well? I want to make the suggestion that the Committee on Trucks and Tractors be reinstalled and that this Committee handle the railroad car alone."

The Secretary: "In answer to Mr. MacNab, it was felt that the Truck and Tractor Committee had several years of work and the reports in the last few years were practically a repetition of the data furnished in recent years. It was thought that there was not sufficient new development in truck and tractors to continue a committee of that kind for this year."

Mr. Minick: "Mr. Chairman, I move you that the report be accepted and the Committee continued."

Mr. Billau: "I second the motion." *Motion carried.*

FRIDAY SESSION

The Friday session was opened with the presentation of the report of the committee on Train Control. F. E. Starkweather, electrical and assistant signal engineer of the Pere Marquette, presented the report. The discussion was opened by the president who spoke as follows:

"Gentlemen, you have heard the report of the Committee on Train Control. The report is now open for discussion. Maybe some of you would like to ask Mr. Starkweather some questions. It is a live subject and we ought to get quite a little out of it."

Mr. Minick: "In the first paragraph under Section A, 33-volts is recommended as the voltage of the generator. The American Railway Association has adopted 32 as its standard for locomotive headlight service. That is the voltage of the generator, and this Association likewise has adopted the same voltage. I do not see any good reason now at this late date for changing the voltage which is already recognized as standard by this Association and other associations."

Mr. Starkweather: "The Committee will consider that. Of course, these are simply suggestions."

Roy Liston (Santa Fe): "On the Santa Fe we find that for ordinary headlighting, using No. 14 wire on circuits, that 32-volts at the generator is not sufficient to give the proper voltage at either the headlight or the cab light, especially the headlight."

Mr. Minick: "It is a very easy matter to buy 30-volt or 31-volt lamps, and I do not see any reason for changing our standards as long as we can do that much easier than we can to change our standards."

The President: "Any man who operates a turbo-generator on a railroad naturally has to set it a little high to get 32 volts in the headlight lamp. That is why you have a 33-volt cab lamp and a 32-volt headlight lamp, and if Mr. Minick was to make a motion that this be changed to 32, I see no harm in it. They are not so very far off because you do get 33-volt cab lamps and that is the A. R. A. standard."

Mr. Minick: "I will make that motion." *Motion carried.*

The President: "Mr. Muelheim, what is your Committee's reaction on that subject of the generator voltage?"

L. C. Muelheim (B. & O. R. R.): "Our Committee is of the opinion that the voltage ought to be retained at 32 volts to be in line with the present headlighting generators."

Mr. Minick: "I am not favorably inclined towards the recommendation in Section D: 'We favor the use of No. 14-24 R. S. A. terminal posts with one-half inch hex nuts for the engine wiring.' I think this matter of bolt and screw sizes, bolt and screw threads, is one which could very readily be studied to some extent by this Association with the view of recommending to the manufacturers of electrical apparatus purchased for railroad use the kinds and sizes of screws that should be used for various classes of service."

Mr. Liston: "I am entirely in agreement with Mr. Minick in going further into this screw and bolt size, but along with that I would like to see some specific and definite recommendations as to the amount of metal through which this screw must pass, that is, the number of threads, holding threads for the screw."

Mr. Minick: "There is nothing said there about the character of the conduit fitting. I would like to recommend either wrought steel or malleable castings. In other words, I do not like the idea of using a gray iron casting, a brittle casting."

The President: "I don't agree with you on that, Mr. Minick. We have had very good success with gray iron castings. It all depends on what size you use. If you get down to half-inch stuff you are in trouble. If you keep around the three-quarter inch you do not have trouble."

Mr. Starkweather: "I do not think the members really understand what this report is about. This is simply information that we are trying to give. As far as making recommendations at this time and standardizing on fittings or any particular type of mechanism, I do not think we should do that. We finished up our report here asking that it be accepted as information. We feel it is a live subject and we do not feel we should be too hasty in our actions in making recommendations as to fittings and parts to go to make up the automatic train control system."

Mr. Sloan: "I would like to have a little discussion on the first line of C. 'We favor use of water tight screw cover or gasket cover conduit fittings.' I do not think that is permissible, not from my experience."

Mr. Minick: "I might emphasize that point, Mr. Chairman, to this extent, that when train control is once applied it is going to be necessary to have a very high degree of insulation resistance, a very high grade of insulation, and the smallest amount of water in your conduit system is going to cause trouble with the operation of your train control."

Mr. Miller: "We have found that in spite of all the pains we took to make our conduit water tight, we got into difficulty because of water inside of the conduit. It seems to me all you can do is to put vents in your conduit."

Mr. Liston: "We tried very diligently to make a water tight job, that is, an air tight job to exclude air circulation. It was a complete failure. The condensation from the air that was originally contained in the conduit, if for no other reason, was sufficient to accumulate moisture. We went to a drainage system and we had all kinds of trouble from leakage across terminals due to this sweating, but by carefully arranging the conduit to drain certain low points and then drilling three-sixteenths or a quarter-inch hole we were able to maintain our circuits at sufficiently high insulation to take care of our requirements."

The President: "Do I understand you, Mr. Liston, that you put in your conduit and get it as water-proof as you can and then you provide drainage?"

Mr. Liston: "In applying the conduit we take care to have certain low points, and put a fitting there that can be drained. May I give you just a little of my experience on the ground situation?"

Mr. President: "Surely."

Mr. Liston: "In checking for grounds, in all cases we require a megohm and on the grid circuits we require three megohms. Anything less than that must be run down on the 32-volt circuit of the engine."

Mr. Ganzert: "I am trying to find out what the wire people mean when they say to clean the joint after it is soldered. What are you going to clean it with and how are you going to clean it?"

Mr. Liston: "We take care of soldered joints on train control and practically everywhere on headlighting by simply eliminating them. We do not permit any soldered joints."

Mr. Young: "For Mr. Ganzert's information, on the Big 4 I would like to say that we have found it generally effective on soldered joints to use an Insu-Lac thinner. In cleaning the joint we have found it very effective. It does not harm the insulation, and it is a thorough job of cleaning."

Mr. Smith (Rock Island): "I think the answer to this is a flux that is non-corrosive. As long as you use a flux that will corrode your wire there is a likelihood of not getting it clean, no matter what agent you use to clean it with."

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†See page 357, this issue *Railway Electrical Engineer*.

Mr. McAllister (Electric Service Co.): "We have found that the use of a liquid rosin, of which there are a number of kinds available, has been successful in stopping corrosion trouble. It requires a hot iron, but works successfully."

Mr. McGinnis (Pyle Nat'l): "I did not know that there was any trouble with soldering terminals. The electric traction people for a long time have used and are still using alcohol and rosin. The joints are clean and the solution of alcohol and rosin is of a consistency that would not allow the dope to run off regardless of the position of the wire."

The Secretary: "It is very apparent that the work of the Committee on Train Control and the Committee on Locomotive Lighting equipment must necessarily be co-ordinated. I believe the discussion largely that is now taking place will rightfully come under the discussion of the Locomotive Lighting Committee's report. I therefore suggest that as the various points of this have been covered that a motion would be in order to receive the report and continue the Committee and go on with the locomotive lighting report in which all of these questions will be brought out." *Motion carried.*

The report of the Committee on Locomotive Lighting was then presented by Mr. Muelheim and the discussion continued.

Mr. Sloan: "Mr. Chairman, I move that it is the sense of this meeting that we favor the single generator for train control headlight."

Mr. Minick: "I second the motion." *Motion carried.*

Mr. Minick: "Mr. Chairman, I am not entirely satisfied in my mind, although I am a member of this Committee and signed the report, that we are yet ready to recommend definitely a 750-watt turbo-generator. I know it is the practice to use that. I know also that it is possible under favorable conditions to use the existing turbo-generator equipment, 500-watt equipment, and I for one would like to hold that question open for possibly another year until we can get a little more definite data on that particular point."

Mr. Liston: "Mr. Chairman, I have been following this matter up very closely the last two years. We equipped our engines with train control. We had practically all Pyle B-2 generators, 500-watt machines. Our engine load, normal load with train control cut in is something like 525 or 550 watts, and the machine has carried the load in very good shape. However, the degree of maintenance is a little higher than we care to maintain, that is, the brush alignment and commutation must be very good or we get into trouble. For that reason we are buying 750-watt machines and applying them to train control engines. This we find gives much more satisfactory operation."

Mr. Bebout: "It is my recommendation that we drop the recommendation for the 750-watt machine. I feel that we can get satisfactory results with the 500-watt machines as they are at present. We have a motor-generator set with the 500-watt machine for charging batteries. It is working very nicely and we have not had the batteries off of the engine since last March or April. They are kept fully charged all the time and in good condition."

Mr. Jansen: "For continuous automatic train control you have to have a larger than a 500-watt machine. There are a good many cases where the load will run 520 or 540 watts on a stoker fired engine."

Mr. Muelheim: "Mr. Chairman, it will be noticed the report recommends not less than 750 watts. In view of the fact that certain service requires more than 500 watts at present it would seem satisfactory to leave the recommendation as it reads, not less than 750 watts."

Mr. Minick: "I cannot agree with that. I personally feel it may be a little premature."

Mr. Liston: "I think that the various types of train control are in a state of development. If there are some possibilities in this development for bettering their equipment they should not be limited. If it is going to take more power, I think they should use it. For that reason I still prefer to see the Association on record as recommending a larger generator, however, incorporating in that that the present 500-watt machine might do for certain types of control."

The Secretary: "I suggest to the Committee that the definite recommendation be withdrawn and that the Committee instead of making a definite recommendation at this time for a 750-watt machine show instead that the trend of the present automatic train control development indicates the possibility of a 750-watt machine being required and to give the matter further study with the view of making a definite recommendation at the next convention."

Mr. Minick: "I second the motion." *Motion carried.*

Mr. Burns (N. Y. C. R. R.): "Here is a short sentence that I want to put some emphasis on: 'The characteristics of the generator should be such as to produce a smooth voltage wave, reducing any voltage irregularity to the minimum.' As we all understand, certain variations in the train control will cause an application, and I think that we should emphasize this point of voltage regulation very closely."

Mr. Sloan: "Mr. Chairman, this question about the pulsation of rythm is mentioned here. I do not think that has anything to do with voltage regulation."

The President: "That question is a very vital one where you use continuous induction train control or any train control that requires an amplifying apparatus, but on train controls that do not use amplifying apparatus it hardly enters into it."

Mr. Liston: "In that connection we ran into trouble with generators on account of interference with the 60 cycles. The headlight generator is designed to run at a speed other than the multiple of 60, and I believe we are fairly safe as far as interference is concerned. We have at least three, possibly four types of generators to take into consideration, and they seem to give satisfactory operation in regard to any interference with commutation."

The President: "You are all familiar with the fact, I believe, that there is an A. R. A. vote going around now and you are being asked to tell how many of you have been using an S-14 lamp and what service you get out of it compared with the S-17 cab lamps."

Mr. Billau: "It is quite important that this association take some action relative to definite recommendations this year, if possible, inasmuch as the contemplated changes in the various schedules of incandescent lamps during the coming year, make it necessary for the lamp people to know where we stand with respect to lamps for locomotive service.

"I, therefore, make that as a motion that it is the sense of this convention that the S-14 cab lamp be ultimately adopted as a standard cab lamp."

Mr. Callahan: "I second the motion." *Motion carried.*

Mr. Billau: "The next lamp that is under consideration is one that is more important. There has been an increasing use of the 250-watt lamp in the G-25, and now in the P-25 bulb, or in other words, in the same bulb as the lamp that is used for switching locomotive service."

Mr. McElree: "I should like to ask just what advantages are to be gained by adopting the smaller lamp over the larger one, if any."

Mr. Billau: "It is my understanding from the lamp industry that the G-30 bulb is one of the bulbs that will disappear from the market ultimately, and if that bulb is retained solely for the use of the headlight demand, the total demand would be comparatively small and consequently it keeps the cost up."

Mr. Callahan: "Mr. Chairman, I believe if we are going to use the same size bulb for both service that there should be some exterior sign by which the two lamps could be noted; that is, in passing through an enginehouse or meeting an engine in the station that it would be possible, by looking at the lamp, to determine whether or not the proper lamp was in there."

Mr. Billau: "I will put the motion in this form: Is it considered necessary that the two sizes of headlight lamps have some means for differentiation that can be ascertained from observation with the lamp in the headlight case?"

Mr. Minick: "I second that motion." *Moticn carried.*

Mr. Billau: "The next point on the lamp question that is desirable to have an expression of opinion on is: Are the railroads in favor of adopting the 250-watt P-25 headlight lamp in place of the present 30 lamp with the understanding that the lamp, of course, will give equal or better performance?"

Mr. Marshall: "The Great Northern has made this lamp standard in the last two or three years and we find that there are no difficulties at all. We prefer the P-25 lamps to the larger lamps."

Mr. Gardner: "We have adopted the smaller lamp on the Burlington and have had it in use perhaps two years. We are very well satisfied with it and would not want to change back."

Mr. Minick: "I would make a motion that the 250-watt lamp in the P-25 bulb be adopted as an alternate standard lamp. My

object in making the motion in that way is that the G-30 bulb will continue to be available for those who wish to use it."

Mr. Billau: "I second the motion." *Motion carried.*

The next report presented was that of the Committee on the Loose Leaf Manual. Mr. Billau, who is also chairman, spoke on the subject of the manual as follows:

"The association contemplates bringing out a manual in form identical with that of the mechanical division manual of the American Railway Association, and also similar form binders used by the signal division.

"The initial issue will cover principally the subject matter as listed in this report; that is, train lighting, some work pertaining to the headlights, motor specifications, the illumination lighting practice manual and the manual on welding which will fit in the new binder.

"Those of you who may be familiar with the practice of handling the manual in the American Railway Engineering Association know that it is a part of the routine duty of every committee to submit definite recommendations each year covering, first, changes in existing matter in the manual; second, new material to go into the manual, and, third, any obsolete material that should be removed from the manual. Those recommendations, as I understand, are subject to final review by the Executive Committee who finally put the information in the manual. If the committees will keep that in mind next year, I think the instructions to the committee will also cover it specifically, that is the only thought I want to leave this morning with respect to this new manual."

The Secretary: "The Committee on Loose Leaf Manual has worked industriously in getting up data. There is very little encouragement for a committee of that kind going to work and putting forth the effort they have in going through all the past proceedings and arranging the matter for you so that you can have it in a condensed form.

"Now, the binders will be presented to you at cost to the association plus the postage. Regarding the welding manual your Executive Committee has not as yet decided what to do with it. We are anxious to send one of these books as it is passed around to everyone who has use for it."

Mr. Marshall: "Mr. Chairman, I should like to inquire if the railroads should decide that they want to buy these in quantities whether they will be available?"

The Secretary: "They will be available and, as nearly as I can say now, they will cost $1.50, just what it has cost to print them."

The President: "We will now hear from Mr. Wanamaker on the welding manual."

Mr. Wanamaker: "Mr. Chairman and gentlemen; I have not much to say about the welding manual, except for those who might not know it, I might say that this manual is indexed so that it shows arc welding, spot welding, butt welding, rivet heating, metal furnaces and heat treating.

"The committee worked extremely hard and tried to put into this manual only such data and information and only such processes and methods of application as had been tried and found qualified and worthy. Anything that was in the experimental stage of development in any sense was not included in the manual."

The President: "Gentlemen, this concludes the program of today. Is there any other business to be taken up? If not, we will entertain a motion to adjourn."

The meeting then adjourned.

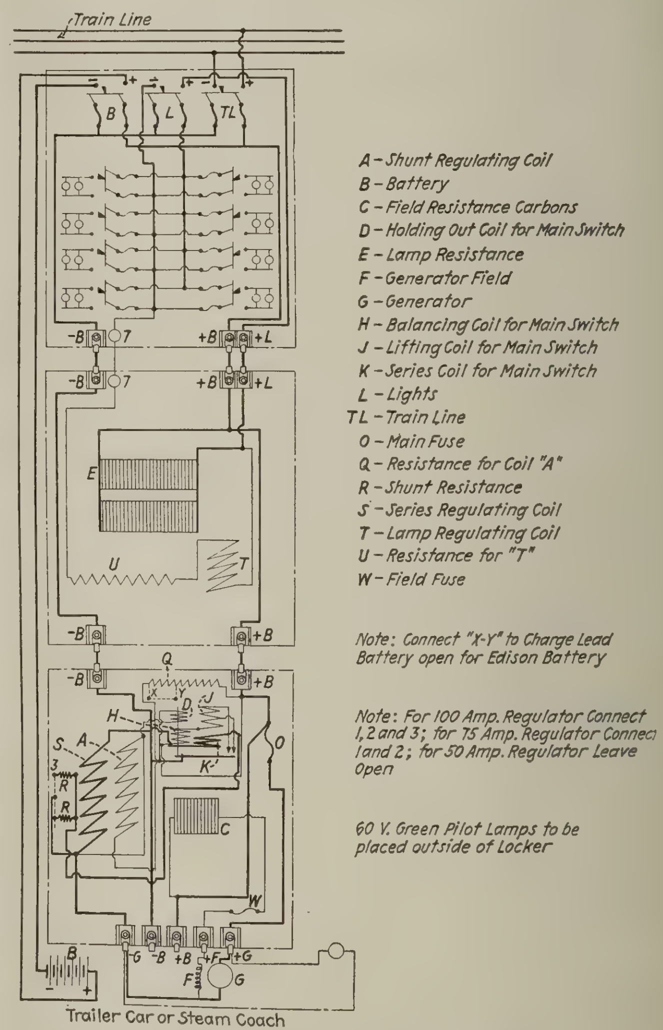
Election of Officers

For the coming year the following officers were elected: E. Wanamaker, Chicago, Rock Island & Pacific, president; C. R. Sugg, Atlantic Coast Line, first vice-president; E. Marshall, Great Northern, second vice-president; L. L. King, Atchison, Topeka & Santa Fe and R. G. Gage, Canadian National Railway were elected as new members of the executive committee. The nominating committee will consist of A. J. Farrelly, Chicago Northwestern; L. S. Billau, Baltimore & Ohio; E. S. M. MacNab, Canadian Pacific Railway; F. J. Hill, Michigan Central; E. W. Jansen, Illinois Central.

The Railway Electrical Supply Manufacturers Association also elected officers for the ensuing year. The officers chosen are as follows: E. A. Lundy, E. A. Lundy Company, Pittsburgh, president; W. H. Fenley, Kerite Insulated Wire & Cable Company, Chicago, first vice-president; George R. Berger, Gould Coupler Company, Chicago, second vice-president.

New Regulating Panel

There are certain features concerning the new regulating panel which the Safety Car Heating & Lighting Company has recently introduced and which was illustrated and described in the New Devices Section of the *Railway Electrical Engineer* for October, which are of unusual interest to car lighting men. The diagram shows a circuit arrangement. This panel includes the new switch mounted with a standard type FF field regulator and the complete panel is known as the type FF-10 generator regulator. It will be noted that the coil "D" is connected across the contact of the switch so that the voltage impressed across it is the difference between



Wiring Diagram of the F F-10 Panel

battery voltage and generator voltage, and if the generator is not operating, the full battery potential is available. The pull of this coil on the auxiliary plunger locks the switch in the open position. At the same time the current from the battery which energizes this coil also serves to energize the field of the main generator so that it will always be built up in the proper direction.

On the type FF generator regulator with the old style switch, a high resistance was connected across the contacts of the switch in order to insure the proper polarity of the generator. The drain on the battery with the new switch is no greater than it formerly was with the dead

resistance, but it will now be seen that this small amount of "sneak" current has been utilized for two purposes—energizing the main field circuit and locking the main switch open.

The coils "J" and "H" are in series across the generator, so that as the generator builds up coil "J" tends to close the switch while coil "H" serves to replace coil "D" which becomes inoperative as the generator voltage approaches that of the battery. The design of these coils is such that the correct balance is obtained at any voltage between 12 and 40. Consequently, when the armature is set with the proper gap, the switch closes when the generator voltage equals that of the battery.

The series coil "K" serves to lock the switch closed when the generator is charging the battery and also serves to neutralize coil "J" when the battery attempts to discharge to the generator. The tap from coil "J" brought out to the contact on the switch serves to reduce the strength of the coil "J" so that a very small discharge from the battery will open the switch. It is thus possible to eliminate the carbon contacts formerly used.

Due to the fact that the operation of this switch depends upon the balancing of the voltage coils "D," "H," and "J," the effects of temperature changes in the coils cancel each other. It is, therefore, not necessary to place resistances with zero temperature coefficients in series with the coils to obtain the same operation under various changes of temperature.

Additional Convention Reports

Sections for Illumination Manual and Report of Self-Propelled Vehicles Not Included In Convention Issue

OWING to the fact that some of the material which normally would have been included in the October issue of the *Railway Electrical Engineer* was not received up to the time of publication, two sections of the Illumination report and a progress report of the Committee on Self-Propelled Vehicles are presented in this issue.

The two sections of the Illumination report form parts of the lighting manual which the Association of Railway Electrical Engineers expects to issue in the near future. These were referred to by L. S. Billau, chairman of the Committee on Illumination on the convention floor. It is believed that by presenting them in this way before they appear in the final form an opportunity will be afforded the members of the Association to suggest changes that seem desirable so that when the manual finally appears, it will be as nearly ideal as possible.

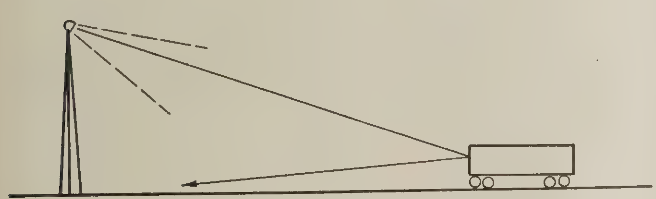


Fig. 601—Vision by Reflected Light

SECTION 6—Yard Lighting

600—General

The subject of the artificial illumination of railroad yards is of increasing importance as it is becoming more generally recognized that adequate lighting will result in the speeding up of night operation of the yards, reduction in damage to equipment, promoting safety and aiding in the prevention of pilfering.

The tremendous areas involved, the relatively poor reflecting surfaces encountered and the atmospheric conditions prevailing in railroad yards make it extremely difficult to provide economical systems of lighting which are satisfactory from every point of view. The present tendency in yard illumination is very largely toward the use of flood lighting in preference to the use of units distributed along the edges of the yard with occasionally a line of units down the center. Consideration of maintenance, besides effectiveness of illumination has swung the balance in favor of projected light since all the units are concentrated in a small number of groups where they are more easily maintained. In the case of existing yards, space for placement of lighting units is often at a premium and the flexibility of the projector system as regards tower location is another point in its favor.

Due to the few groups of projector units commonly required high towers can be employed which would be out of the question if a large number of distributed units were used. The use of high towers, 70 to 125 feet, is much desired as its glare is reduced and visual conditions in general are improved.

601—Systems of Flood Lighting

Aside from the engineering features which must be considered in the design of a yard lighting installation, certain factors of vision, which have an important bearing on the design of the system must first receive attention.

Vision, in general, depends upon two things, contrast in color of objects and contrast in brightness of objects. With the very low intensities necessarily employed in yard lighting the perception of color is very difficult; so that objects in the yard area are seen largely by difference in brightness alone. In the matter of vision resulting from contrast in brightness, objects are seen either by the light which they reflect to the eye, which is the basis of all direct vision, or by silhouette.

Both of these principles are employed in present day yard lighting systems and since to obtain either condition involves only a change in direction of the projected light with respect to the observer, these systems have come to be called *Unidirectional Floodlighting and Parallel Opposing Floodlighting*.

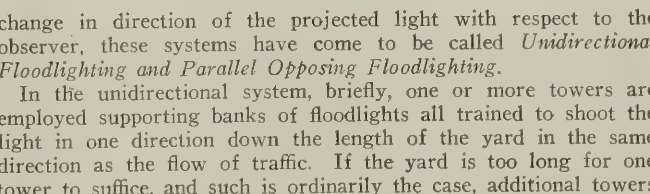


Fig. 602—Vision by Silhouette Assisted by Glint from Rails

In the unidirectional system, briefly, one or more towers are employed supporting banks of floodlights all trained to shoot the light in one direction down the length of the yard in the same direction as the flow of traffic. If the yard is too long for one tower to suffice, and such is ordinarily the case, additional towers are used to cover the entire yard length.

In the parallel opposing system the yard is divided into a number of convenient lengths depending upon the "throw" of the projectors employed and a tower is located at each end of each section, the units placed on the towers at the ends of a section

in such a way that they will throw opposing beams of light.

With the unidirectional system, when looking in the direction in which the beams are shooting, all objects are seen by reflected light, Fig. 601, so that if the intensity of light is high enough detail vision is rather good. When looking against the beams, however, vision is largely by means of silhouette, and the glare from the units is somewhat objectionable so that the unidirectional system is well adapted to those yards where the traffic is predominately in one direction.

In the case of the parallel opposing system, objects relatively near the towers are seen by reflected light and those remote from the observer are seen by silhouette, assistance in locating the objects also being rendered by high lights on the sides of the cars and the glint from the rails, Fig. 602. When looking in either direction, up or down the yard, the units themselves will naturally be visible. The glare thus encountered will be considerably reduced by using high towers and will be further reduced by the action of the units behind the observer opposing those into which he is looking.

In connection with the visibility of objects within the yard area, if it were practicable to have a white band painted along the top edge of each car on both ends, it would greatly facilitate perception of individual cars, with consequent reduction in damage to equipment.

602—Fundamentals of Projection

Before taking up the subject of installation design proper, it is first necessary to consider some factors which have a direct bearing on it.

The projection of light, in the form of concentrated beams, is effectively accomplished by means of a parabolic mirror. In theory, the parabolic mirror possesses such optical properties that when a point source of light is placed at the focal point of a perfect mirror each point on its surface will reflect the light it receives from the source in a direction parallel to the principal axis of the mirror as shown by Fig. 603-A. Since no mirror is perfect and every light source possesses appreciable area, this theoretical condition can never be attained so that each point on the mirror, instead of receiving a single ray of light from the source, receives a cone of light which it reflects; the angular "spread" of the cone before and after reflection, being the same, as shown by Fig. 603-B. The angular spread of the cone of light reflected by any particular point on the mirror will depend upon the size of the light source and its distance from the mirror point in question and since the source is not equi-distant from all points on the mirror the final light beam will be composed of a large number of light cones all varying in angular spread. The light source is always nearest to the central point of the reflector, and consequently the reflected

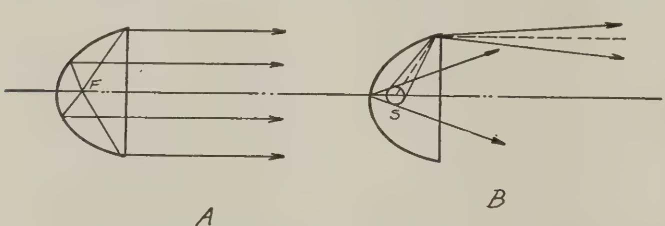


Fig. 603—Light Reflection by Parabolic Mirrors

cone from this point will have the greatest spread and at some distance from the reflector this cone will include all others so that it will really measure the spread of beam from that particular projector. The beam spread of a projector can, therefore, be varied by either changing the size of the light source or by changing the focal length of the projector which will necessitate placing the source either closer to, or farther away from the mirror. The effect of changing the light source size is illustrated by Fig. 604-A and B.

In any given projector, a limited variation in the distance of source from mirror is possible by moving the source either nearer to, or farther away from, the reflector along the principal axis. While the tendency is for the beam spread to vary in accordance with the angle subtended by the light source at the center of the mirror, the ultimate effect is to widen the beam in each case and if carried too far, a dark spot will appear in the center of the beam, surrounded by bright rim, or ring, of light, Fig. 605-A and B.

The principal difference between searchlights and floodlights is one of focal length. The former are essentially of great focal length to secure narrow spread of beam, and large diameter to build up the beam candle power, whereas, the latter are of short focal length to secure wide spread (thus intercepting a large volume of light flux from the lamp) and their diameter is necessarily limited.

From this it follows that searchlights are adapted for illuminating relatively small areas at great distances, whereas floodlights are used to illuminate large areas at short distances.

In terms of beam efficiency, which is measured by the ratio of lumens in the beam to the total lumens emitted by the lamp, floodlighting projectors have the advantage since the short focal length necessitates a deep reflector which picks up a large angle of light and redirects it into the beam, whereas the searchlight, due to its great focal length, intercepts but a small angle of flux from the lamp.

603—Illumination Intensities

Common agreement among leading authorities on yard lighting shows that the proper method of specifying railroad yard lighting

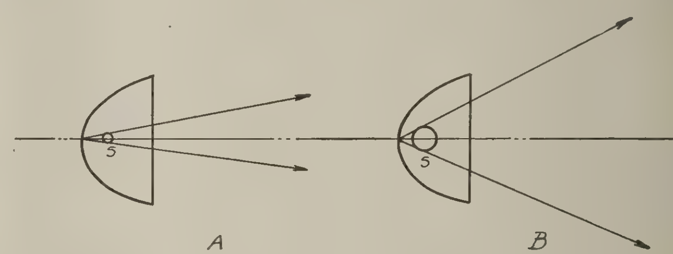


Fig. 604—Light Rays from Yard Lighting Reflectors

values is in foot candles on the horizontal plane. It should be realized that because of the very acute angle at which the light from projectors in a yard flood lighting system falls upon the horizontal plane at appreciable distances from the towers, the illumination on this plane is much lower than on the vertical plane. As a consequence it is possible to have a very low intensity of illumination on the horizontal plane and still have sufficient illumination throughout the yard and on the ends of the cars for the purposes required.

Very little data is as yet available relative to the intensities of illumination required in railroad yards to secure the maximum economical benefits from artificial illumination. In general, the minimum average intensity for classification yards or similar switching yards should not be less than 0.05 foot candles on the horizontal plane, with a recommended value of 0.10 average horizontal foot candles. In connection with the specification of foot candles on the horizontal plane caution should be exercised when attempting to check these values by measurements in yards since the actual values will depart considerably from those recommended which represent merely an arithmetical average of the values. Thus the intensities near the towers will be relatively high, while those that are remote will be so low as possibly to preclude measurement by ordinary means. This method of specifying illumination values, however, is very useful in deriving a simple formula for designing such lighting installations and is given principally for this reason.

The subject of scale house lighting is treated in detail further on, but where no scale is provided in the yard some local lighting is required at the hump. It is possible in many cases to utilize the stray light from the main yard lighting units, but if this is insufficient separate lighting units must be provided to take care of this location.

604—Design of Lighting System

The art of flood lighting as applied to railroad yards is developing so rapidly that it is impossible to present at this time engineering formulæ and instructions that will aid greatly in laying out properly flood lighting systems for yard lighting.

The total number of projectors required can be readily approximately ascertained. Multiply the area of the yard in square feet by the average intensity of illumination on the horizontal plane in foot candles, which gives the total lumens required in the yard. Divide the total lumens by the lumen output in the beam of the

particular projector to be used which will give the total number of projectors required.

The location and spacing of the towers depends largely upon the type of projector used, the general system of flood lighting that is being followed, and which are more or less affected by physical and other considerations bearing upon the tower location. Engineering data on the effective ranges of the flood lighting projectors for various angles, the divergence of the beam, lumen output of the unit, etc., is furnished by the manufacturers of the lighting equipment. The proper locations of the towers must be determined largely by experience and the use of common sense.

The height of the tower is important since upon this depends the effective distribution of light over the yard and the degree of glare encountered. Ordinarily the higher the tower the better, since the angle between the projected beam and track level then becomes less acute. In general the minimum tower height should

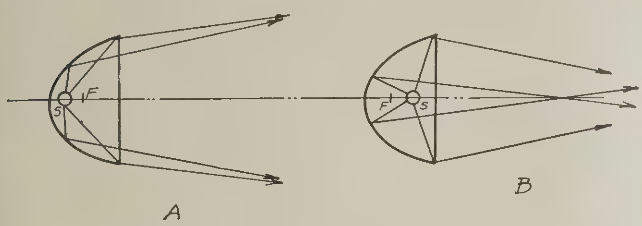


Fig. 605—Effect of Position of Lamp Center

not be less than 70 feet and preferably 90 to 125 feet for the high powered, long range types of units.

The performance of the average run of commercial projectors from a light point of view falls within certain limits, and while it is not the intention to offer a guide in selection of the units, it is well to call attention to a few points which are common to all parabolic reflectors. In general, the narrow beam is more to be preferred, though this should not be obtained at the expense of efficiency. While it is not possible to make the beam of any projector narrower than when the lamp is in focus, it can be widened somewhat by either moving the lamp back of focus (closer to the mirror) or by adding a special glass door to diffuse the light over a wider angle. This latter practice reduces the beam candle power materially but considerably adds to the spread in addition to increasing the overall efficiency somewhat due to including "the stray light" within the beam. Such a wide beam is felt desirable for illuminating local areas at relatively short throws up to 500 feet.

605—Scale House Lighting

The principal requirements for scale lighting are shown diagramatically in Fig. 606.

In the scale house, the beam and centerpoise must be clearly visible and at no point should glaring light sources or reflections be present; particularly so from the weighman's stand. The lighting installation of the scale house serves two primary purposes. First, to illuminate the cars as they approach, run on and leave the scale; and second, to light the beam and counterpoise of the scale, and the scale house itself. In Fig. 607 is shown a method of scale lighting which has worked out satisfactorily in practice and is to be recommended for average conditions.

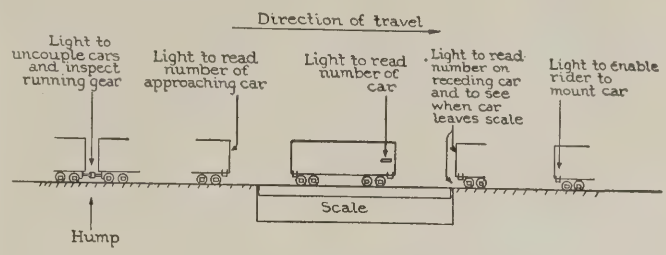


Fig. 606—Requirements for Scale Lighting

The mounting heights of the units shown in this figure were calculated for the conditions of the scale house location and scale length, as shown. Where these dimensions vary greatly from those assumed in this case, it may be necessary, when installing the units, to adjust them as to direction of throw and height, in order to obtain the desired intensity on the sides of the cars during the weighing operation.

For lighting the scale beam and counterpoise a method which has given good results makes use of two low wattage lamps placed in deep bowl metal reflectors, so that the skirt of the reflector entirely shields the lamp from the weighman's vision. These units, which are pendant, are hung seven feet above the

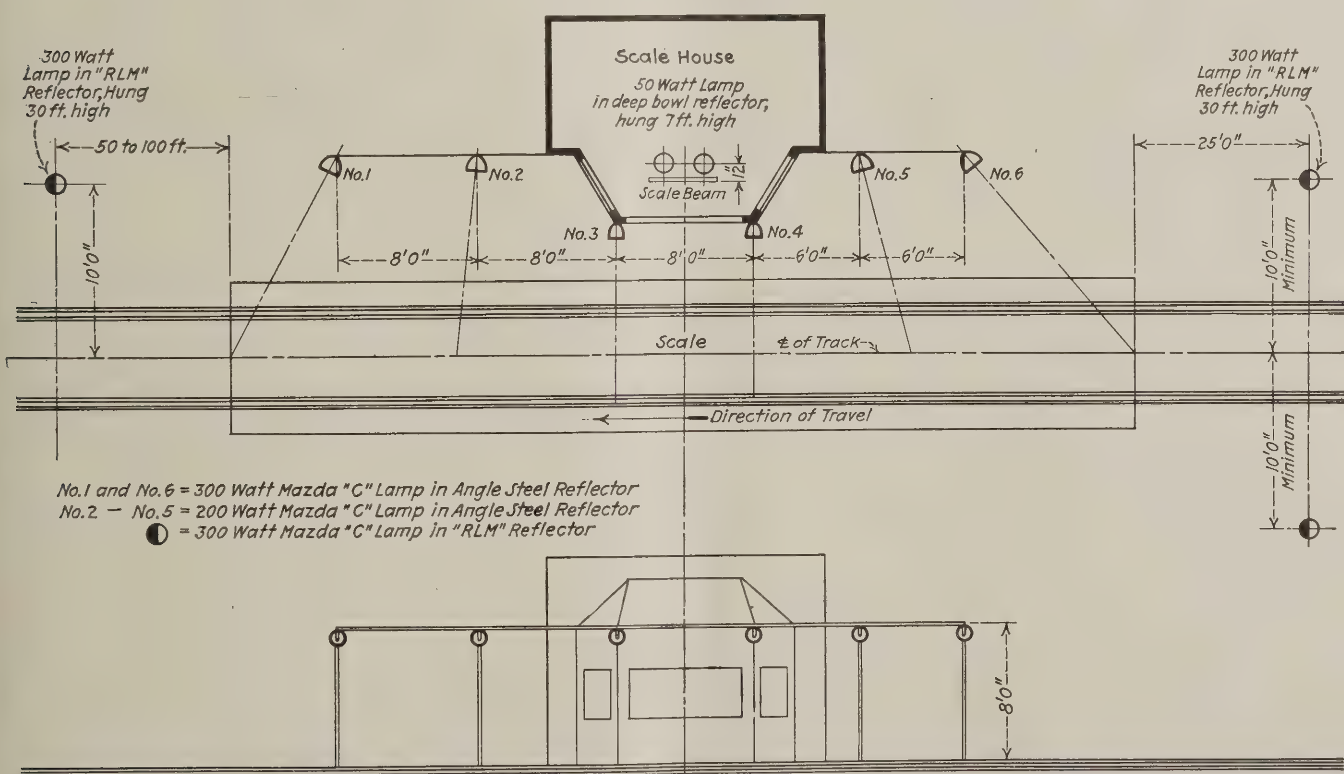


Fig. 607—Showing Method of Scale Lighting in Common Use

floor and approximately 12 in. to the front of and in a line parallel with the beam.

SECTION 7—Car Lighting

700—General

While every type of lighting has been employed in the illumination of railway cars, direct lighting, for economic reasons, has predominated. Progress in the art of lighting has gradually raised the standards of illumination so that adequate intensity with absence of glare, proper diffusion, and artistic design are considered of equal importance with efficiency and economy of operation and are now possible without incurring excessive loads for car generating equipment.

The appearance of a car lighting unit is largely one of individual taste. There is no reason why any efficient lighting unit cannot be clothed with a fixture giving pleasing lines and artistic proportions without seriously affecting its illuminating efficiency. The use of a light colored head lining secures the greatest possible efficiency in the utilization of natural and artificial light and produces a more cheerful effect in the car than where a dark color is used.

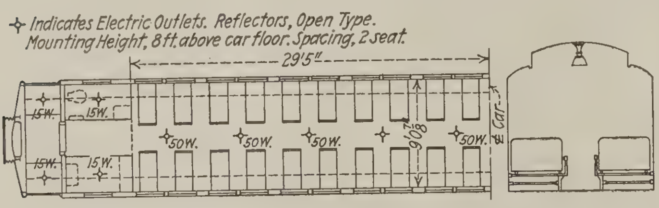


Fig. 701—Day Coach Illumination—Center Deck Mounting—Open Type

Where formerly an intensity of from 2 to 5-foot candles was considered adequate, modern requirements demand an illumination intensity of 3 to 10-foot candles, depending on the class of car to be lighted. The application of the Mazda C lamp has made this higher intensity possible without increasing to any great extent the load on the battery and generator equipment.

Voltage regulation at the lamp socket must be maintained, if maximum results are to be expected of any lighting system. The curve in Fig. 101, Section 1, entitled "Variation in Lumens with Voltage for Mazda Lamps" shows the relation in terms of per cent. For example, if 32-volt lamps are operating at 30 volts, or 93.7 per cent normal potential, the resulting illumination intensity will be only 80 per cent of normal.

The lighting of the different classes of cars will be treated separately and for convenience will be divided into the following: Day Coach Lighting, Baggage Car Lighting, Dining Car Lighting, Sleeping and Parlor Car Lighting, and Mail Car Lighting.

701—Day Coach Lighting

As day coaches carry more passengers than any other class of car, the subject of coach lighting has received more attention than for any other class, excepting mail cars. The Day Coach Lighting Tests conducted by the Association of Railway Electrical Engineers and the Lake Shore and Michigan Southern Railway at Cleveland in 1913 covered the subject exhaustively and established fundamental lighting practices that have become largely standardized.

The essential conclusions reached from results of these tests are:

(1) Equally satisfactory illumination results from the point of view of efficiency, uniformity of distribution, and absence of objectionable shadows (except where a large number of people are standing in the aisle) are obtained with either the center deck of the half deck arrangement of light units. However, on account of the larger number of units involved, cleaning cost, reflector and lamp maintenance are materially greater with the half deck arrangement.

(2) The uniformity of distribution of illumination obtained with spacing of lighting units three seats (approximately 9 feet) apart is so poor as not to justify spacing greater than two seats (approximately 6 feet) where the best illumination results are desired. This does not apply to semi-indirect or indirect lighting where a satisfactory distribution can be obtained with three seat spacing.

(3) With direct lighting systems the color of the head lining has no appreciable effect on the useful illumination produced, except where lighting units are used in which a considerable proportion of light is transmitted to the ceiling. The use of a light colored head lining, however, is recommended as it produces a more cheerful effect in the car than where a dark color is used.

(4) The results of illumination tests show a wide range in the efficiency of the lighting units, the more efficient units producing over twice the useful illumination, compared on an equal wattage basis. Further, the various lighting units can be classified into groups each possessing distinctive characteristics. Table 1 shows a comparison of the groups with reference to their illumination efficiency.

TABLE 1

COMPARISON OF VARIOUS TYPES OF LIGHTING UNITS FROM POINT OF VIEW OF ILLUMINATING EFFICIENCY

All results reduced to same total wattage representing 66⅔ generated lumens per running foot of car

Type of unit	Average illumination on 45-deg. reading planes foot candled: Aisle seats	Window seats	Avge. seats	Illumination efficiency % effective lumens on 45-degree planes
Open moutl. reflectors—				
Mirrored glass reflectors	3.39	2.18	2.79	39.5
Prismatic clear reflectors	2.66	2.17	2.42	34.2
Heavy density opal reflectors	2.41	1.87	2.14	30.3
Enclosing unit—				
Prismatic reflectors (deep bowl type) and bowl	2.15	1.66	1.89	26.7
Open mouth reflectors—				
Medium density opal reflectors	2.00	1.65	1.83	25.9
Prismatic satin finish reflectors	1.94	1.50	1.72	24.3
Light density opal reflectors	1.70	1.52	1.66	23.5
Semi-indirect units	1.56	1.24	1.40	19.8
Diffusing shades (old standard Pullman opal shade)	1.42	1.28	1.35	19.1
Enclosing units—				
Reflecting and diffusing globes (satin finish Corona)	1.44	1.24	1.34	19.0
Reflecting and diffusing type of units	1.46	1.18	1.32	18.7
Prismatic reflector (shallow bowl type) and bowl	1.39	1.09	1.24	17.5
Totally indirect units	1.36	1.11	1.23	17.4
Bare Lamp	1.17	1.13	1.15	16.3
Enclosing unit, light density opal globe	1.09	.97	1.03	14.6

The results of these tests are given in detail in the report on the Day Coach Lighting Tests published by the Association of Railway Electrical Engineers in 1914 and Summary included in the 1913 Proceedings of the Association.

The most important improvement that has taken place since these tests were made is the development of a more efficient mazda C lamp which has permitted not only raising the illumination intensity but using light units providing better diffused illumination without incurring prohibitive consumption of electrical energy.

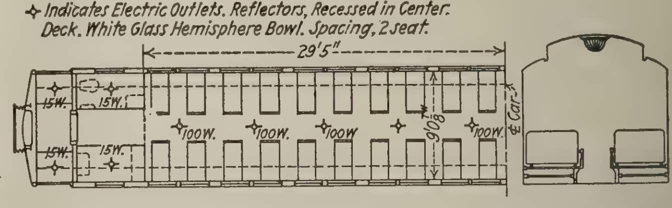


Fig. 702—Day Coach Illumination—Center Deck Mounting—Hemisphere Bowl

The effect on the eye of the illumination produced by any lighting system is one of the most important factors to be taken into consideration, especially under such trying conditions as a moving railway car and with the use of the mazda C lamp. Shallow bowl type of reflectors should be avoided so that the light source will not be within normal angle of vision of the passenger when standing in the aisle or sitting on a seat. Lamps above the 50 watt size should be used only in enclosing or the equivalent types of lighting units. The quality of illumination produced by well diffusing, uniform distribution of light through the car is justified even at some sacrifice in efficiency. In addition to the requirements for general illumination, the system should be designed to provide an adequate intensity for the loading plane, which is 45 degrees to the horizontal and at right angles to the center line of the car.

While equally good illumination and distribution can be obtained either with fixtures mounted on the center or the side decks, the former can be more strongly recommended today than when first

presented in the report on the 1913 coach tests because of permitting the use of a higher wattage mazda C and, therefore, more efficient lamp in diffusing types of lighting units. For coaches used primarily in suburban service where the aisle is at times occupied with people standing, side deck lighting will give more satisfactory illumination for reading as the standing passengers will not cause objectionable shadows on the reading matter of those seated, and this type of lighting is also advantageous where advertisements are displayed in suburban cars.

For satisfactory illumination from the point of view of eye strain and fatigue, illumination values of 3 to 6-foot candles

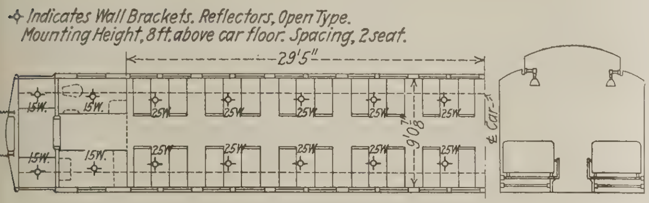


Fig. 703—Day Coach Illumination—Side Deck Mounting

measured on a 45 degree plane at right angles to the center line of the car and 33 in. above the car floor, should be provided in coach lighting. This is equivalent to an average horizontal illumination intensity of 4 to 8-foot candles. An intensity of 3-foot candles on the 45 degree plane should be considered a minimum under which comfortable reading of fine print, such as newspapers, may be done because a higher intensity is required to bring out details of objects in motion than is necessary on stationary objects.

Two seat spacing as compared to three seat spacing of the lighting units has become an accepted general practice and is more or less general use for modern coach lighting service.

It will be noted that the total lumens generated by the 50-watt lamps with two seat spacing represented in 1913, only 66⅔ lumens per running foot of car as compared to 117.5 lumens in 1925.

Vestibule lighting is important as serious injury may result from poor lighting over the steps. On coming from the brightly lighted interior to the dimly lighted vestibule an accident may happen because the eye is compelled to adjust itself to the great contrast of intensity. It is standard practice to provide an outlet over each set of steps equipped with a 15-watt lamp in a porcelain enameled bowl reflector recessed in the ceiling.

Satisfactory lighting of the toilets requires the installation of one outlet in each, equipped with a 15-watt lamp and a glass or metal reflector.

702—Baggage and Express Car Lighting

The importance of providing adequate and properly distributed illumination in baggage and express cars in which crews are working en route is frequently overlooked in effort to economize in the cost of lighting equipment for cars of this class. Not only should there be an adequate intensity of illumination provided on the horizontal plane but on the vertical plane as well such that will allow easy examination of tags and labels. Reasonably good uniformity of distribution should be provided to avoid relatively dark places in the upper parts of the storage space of the car between lighting units.

With the advent of the Mazda C train lighting lamp the lighting practice for baggage and express cars is rapidly becoming standardized. The RLM dome porcelain enameled steel type of reflector which was specially developed for the Mazda C lamp for industrial lighting purposes should be used. Lighting units should be located as close to the ceiling as possible and spacing should not exceed 8 to 9 feet.

Illumination results obtained in a test in a 70-foot baggage car

TABLE 2.—DAY COACH ILLUMINATION OBTAINED WITH MODERN TYPES OF LIGHTING UNITS.

				Average Foot Candles					
Test No.	Test Plane	Size of Lamps Watts	Lumens Per Running Ft. of Car	Window Seat	Aisle Seat	Avg. Seats	Aisle Only	Entire Car	% Illumination Efficiency
A	Hor.	50	117.5			4.18	5.92	4.58	34.6
	45°	50	117.5	3.06	4.4	3.73			28.4
B	Hor.	50	117.5			4.03	5.72	4.40	33.2
	45°	50	117.5	2.97	4.28	3.63			27.5
C	Hor.	100	282			5.96	8.55	6.48	20.4
	45°	100	282	4.35	5.30	4.83			15.3

A—Test made with 50-watt Mazda C lamps in satin finish prismatic glass reflectors located as shown in Fig. 701.
B—Test made with 50-watt Mazda C lamps and heavy density opal bowl reflectors located as shown in Fig. 701.
C—Test made with 100-watt Mazda lamps and enclosing opal glass bowls located as shown in Fig. 702.

recommended even with diffusing types of units because of the much better uniformity of distribution that can be secured.

In the great majority of coaches an open mouth type of reflector, in either heavy density opal or prismatic glass, is employed, preferably with the 50-watt lamp for center lighting and the 25-watt lamp for side lighting. The standard spacing for lamps is approximately 6 ft. both for those mounted on the center deck and on the side deck. The mounting height for the center lamp is about 8 ft. and for the side lamps 6 ft. 6 in. An average illumination intensity of 3 to 4-foot candles on the 45 degree plane may be expected from either installation under normal conditions. Figs. 701, 702 and 703, show plans of locations of outlets for center deck and side deck lighting.

Clear bulb mazda C lamps are now being used to a great extent in open reflectors. In order to avoid any objectionable glare, the lamp should have a diffusing finish.

Another and increasingly popular type of unit consists of an enclosing hemisphere of medium or light density white glass, containing a 75 or 100 watt mazda C lamp and equipped with a porcelain enameled shallow dome reflector recessed in the center deck. The standard spacing for the lamps is 6 ft. An average illumination intensity of 4 to 5-foot candles on the 45 degree plane will result from this system under normal conditions using 100-watt lamps.

The results of illumination tests conducted with the same procedure as the 1913 coach tests in order that comparable data might be secured are given in Table 2 for types of lighting units in equipped with eight center deck lighting units consisting of 50-watt clear Mazda C lamps with 12 in. RLM reflectors (approximately 8 ft. 9 in. spacing) are given in Table 3.

TABLE 3

BAGGAGE CAR ILLUMINATION OBTAINED WITH MODERN TYPE OF LIGHTING UNITS.

Height horizontal illumination test plane above floor	33 in.	46 in.
Horizontal Illumination—Foot Candles.		
Center of car—average		5.3
18 in. from wall—average		4.2
Average for entire car	4.0	4.6
Vertical Illumination—18 in. from wall.		
Location of test station	A	B
Height above floor.		
33 in.	1.7	1.5
46 in.	2.8	2.0
72 in.	8.0	2.9

A—Stations located 18 in. from wall directly opposite lighting unit near center of car.
B—Stations located 18 in. from wall half way between two lighting units near center of car.

Many baggage cars are provided with a doorway lighting unit which throws the light on the ground outside and which is very useful for night time loading. This consists of a special angle metal reflector, using a 25-watt Mazda lamp mounted over which each side door within the car and having local control. If a desk is provided for baggagemen, it is desirable to locate a 15-watt lamp in bowl type steel reflector over the desk with local control.

703—Dining Car Lighting

As the interior decoration and illumination of a dining car reflect the individuality of a railroad, it is quite improbable that

any universal method will ever be accepted as standard for lighting this type of car. Lighting installations for dining cars are usually designed to harmonize with the interior decoration and should provide an adequate illumination as well as convey a comfortable and pleasing effect to the occupants.

All types of lighting are employed in dining cars, although the totally indirect system is used comparatively little owing to the high wattage necessary to obtain a proper illumination value and to the constant attention required in maintenance.

The dining table is, of course, the most important item in the car and should have a higher intensity than that provided by the general illumination system. This is usually accomplished by

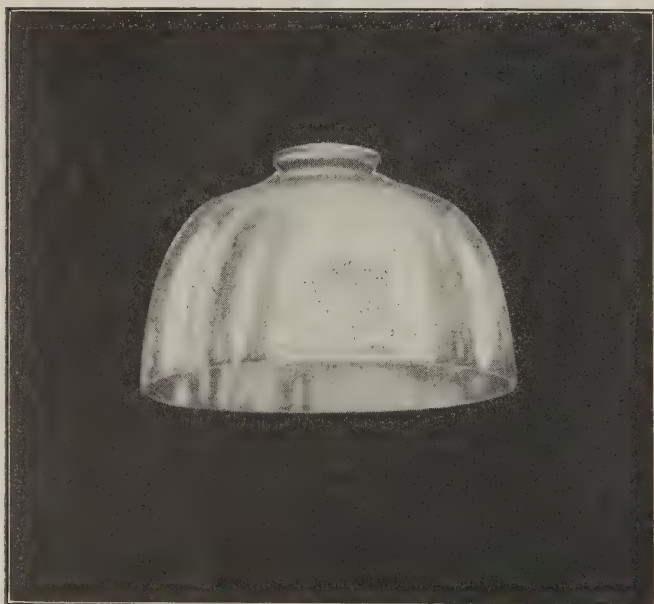


Fig. 704—Opalescent Bowl Reflector

mounting bracket lamps on the sides above the table, units overhead on half deck, or by employing table lamps.

In the dining compartment, the luminaires are usually located on the center line above each pair of tables. Indirect and semi-indirect units are ordinarily suspended from the center deck in order that full advantage may be taken of reflection from the surface of the deck, which should be finished in a very light color for efficient results. The indirect system requires a 100-watt Mazda C lamp for each unit and the semi-indirect system employs a 75 or 100-watt Mazda C lamp. Direct lighting from the center deck is usually accomplished by using either the open type reflector, side deck lighting units located over each table and employing 50-watt Mazda C lamps in preferably fixtures of the totally enclosing type. To avoid a gloomy appearance of the upper deck auxiliary lighting consists of 15-watt lamps in small decorative types of enclosing units mounted on the panels of the upper deck is desirable.

Dining cars having relatively dark shades of interior finish on the center and side decks obviously cannot use the indirect and semi-indirect systems with any efficiency. Units of low intrinsic brilliancy such as clusters of low wattage frosted lamps would be appropriate under such conditions to avoid glaring contrasts. The clusters should consist of 15-watt lamps, diffusing or colored spray finish. It will be necessary to supplement such a system with either side bracket lamps, or half-deck units to obtain an adequate intensity on the tables.

An illumination intensity of 2 to 4-foot candles on the tables is

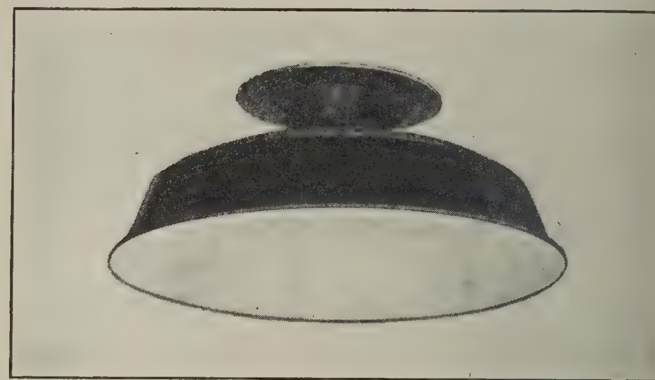


Fig. 705—Metal Reflector for Postal Car Use

considered satisfactory for the general lighting system, with a total of 3 to 6-foot candles when measured in conjunction with the auxiliary system of table lamps or side lights.

The hall is illuminated by two or three units equally spaced on the deck over the passage way. In some installations they consist of diffusing bulbs recessed in the ceiling. A clear 25 or 50-watt Mazda C lamp recessed at each position and covered with a decorative bowl is employed in some dining car hallways and provides an artistic and pleasing effect.

The entrance section to the main compartment usually has one luminaire, like those used for general illumination in the dining compartment, mounted on the center deck. The buffet may be adorned with a small enclosed decorative unit equipped with a 15-watt or 25-watt lamp.

While a variety of methods will always be used in illuminating a dining compartment, a certain degree of standardization is pos-

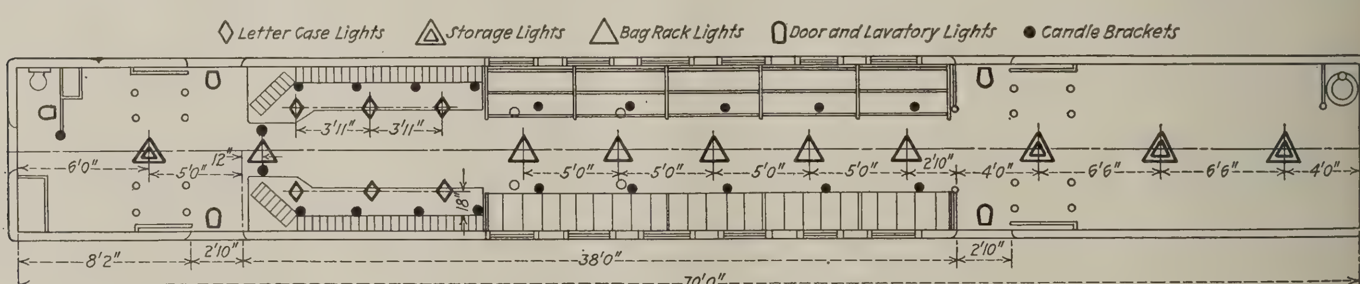


Fig. 706—Standard 70 ft. Mail Car

suspended about eight feet above the car floor, or the enclosing hemisphere of medium or light density white glass mounted against the deck. One unit is mounted on the center line above each pair of tables. The open reflector is equipped with a 50-watt Mazda C lamp, preferably frosted, and the enclosing unit requires a 75 or 100-watt Mazda C clear lamp. If side deck or bracket lights are used, 15 or 25-watt lamps should be provided depending upon the illumination furnished by the center deck luminaires.

In some designs of dining cars where the architectural treatment of the ceiling makes the use of center deck lighting units undesirable the illumination of the dining compartment is supplied from sible in lighting other sections of the car where only efficiency and neatness are the principal considerations.

For lighting the pantry, it is recommended that one or two (depending upon size of compartment) standard RLM dome reflectors or efficient glass reflectors equipped with 50-watt Mazda C lamps be mounted close to the deck. Two or three 15-watt lamps equally spaced and recessed under the cupboards in porcelain enameled bowl reflectors will serve to illuminate the tables, sink, etc.

In the kitchen, two or three (depending upon size of compartment) RLM dome or glass reflectors equipped with 50-watt lamps

and mounted as high as possible will provide general illumination. Two or three 15-watt Mazda lamps equipped with porcelain enameled bowl reflectors may be used to illuminate the tables and sink. To facilitate the inspection of food passed from the kitchen, it is recommended that a 15-watt Mazda lamp equipped with a porcelain enameled bowl reflector be mounted directly above the service window between the kitchen and pantry. The interior finish in both pantry and kitchen should be maintained in a light color for efficient utilization of artificial and natural light.

The refrigerators and closets throughout the car should have one 15-watt Mazda lamp in each compartment and the doors equipped with automatic switches.

Each vestibule or entrance should be lighted with one 15-watt Mazda lamp, preferably equipped with a porcelain enameled reflector and recessed in the deck.

TABLE 4—SLEEPING CAR ILLUMINATION OBTAINED WITH MODERN TYPES OF LIGHTING UNITS

	Foot Candles			
	45° Plane		Horizontal Plane	
	No B.L.*	With 2 B.L.	No B.L.	With 2 B.L.
Aisle	...	...	6.8	6.8
Aisle seat	4.9	6.0	6.2	7.2
Window seat	2.0	4.3	2.9	3.9
Average	3.5	5.2	5.0	5.8

*Berth lamps.

A system of night lighting has been adopted which has proved satisfactory. The aisle night lights are located on alternate seat ends and throw their light downward on the aisles. The lamps used are 15-watt Mazda lamps and the light from them passes through a green glass, illuminating the aisles to a low intensity which does not bother the berth occupants but allows them easy passage through the cars.

Compartments are illuminated by ceiling units similar to that used in the body of the car. Washrooms are illuminated in the same manner, while lighting of the mirrors is accomplished by the use of deep bowl opal glass reflectors employing 15-watt Mazda lamps, and vestibule lighting is of the same type as used in day coaches.

For parlor car lighting the same type, size and location of center deck lighting units are employed as used for sleeping cars. This is augmented by side deck lighting generally using a small enclosing bowl with recessed fixture and 50-watt Mazda lamp.

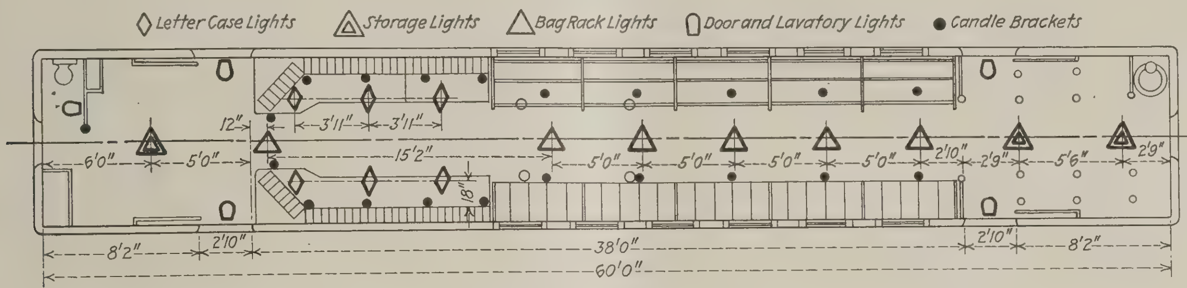


Fig. 707—Standard 60 ft. Mail Car

704—Sleeping and Parlor Car Lighting

In view of the practical standards of the general design of sleeping and parlor cars the lighting of these cars has likewise been largely standardized. The requirements for this class of cars demand in addition to the relatively high intensity of illumination, good diffusion and uniformity of distribution and the use of lighting units that harmonize with the architectural treatment of the car.

The illumination results obtained in a test in one of the latest types of sleeping cars, equipped with center deck lighting units using opalescent bowls and 100-watt Mazda C lamps and with standard berth lights using 15-watt Mazda B lamps are given in

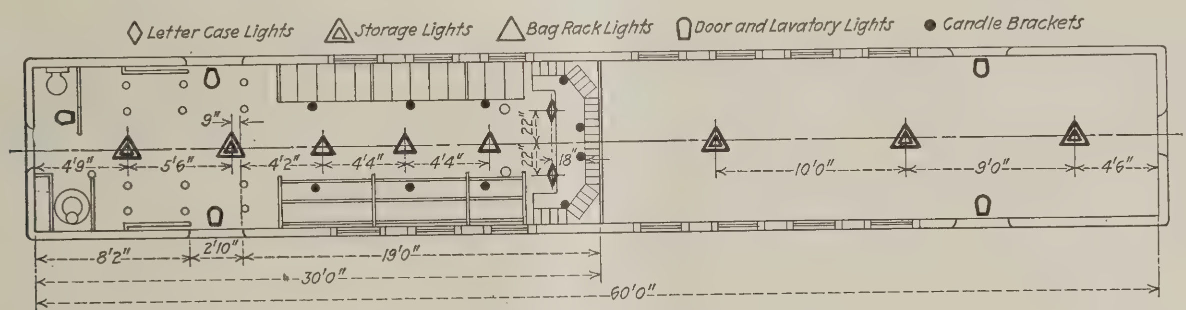


Fig. 708—Standard 30 ft. Mail Apartment

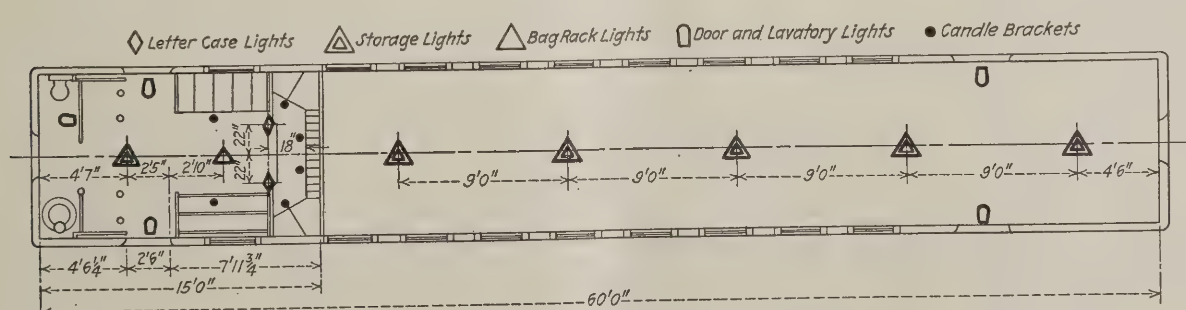


Fig. 709—Standard 15 ft. Mail Apartment

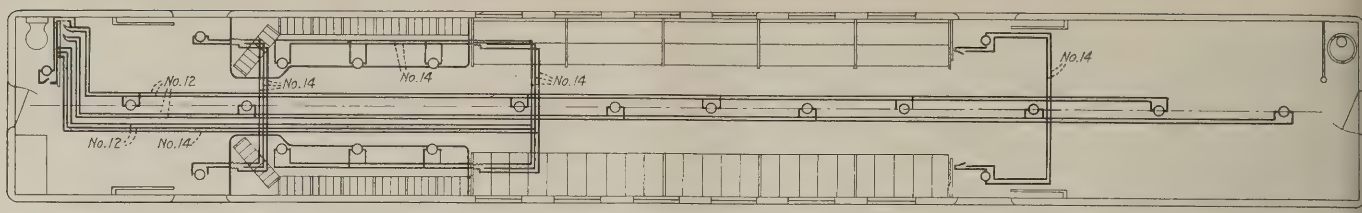


Fig. 710

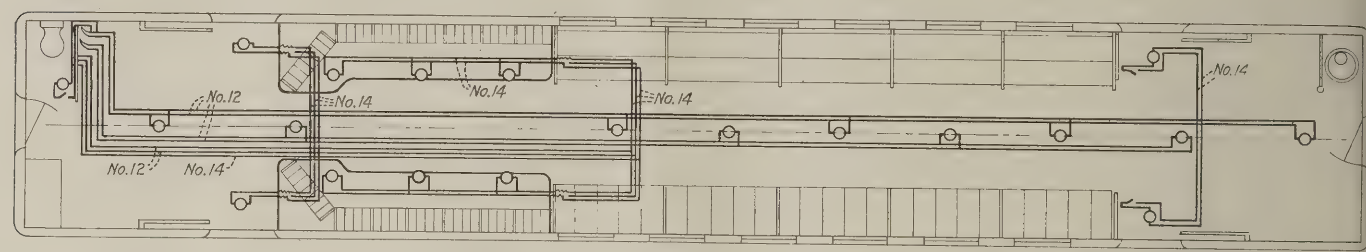


Fig. 711

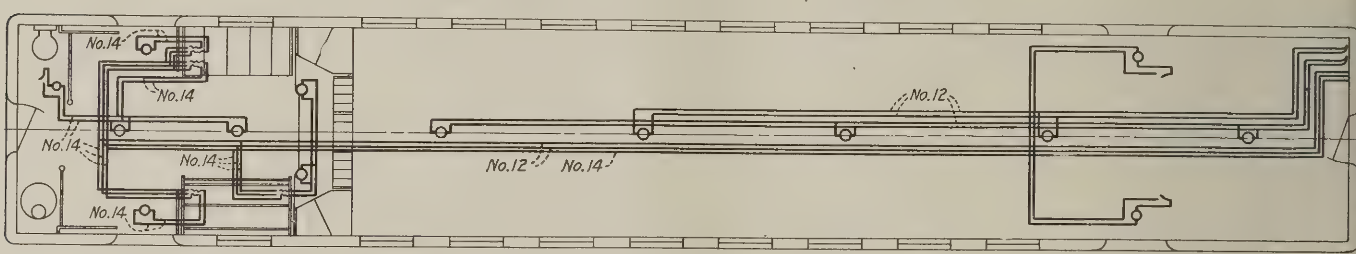


Fig. 712

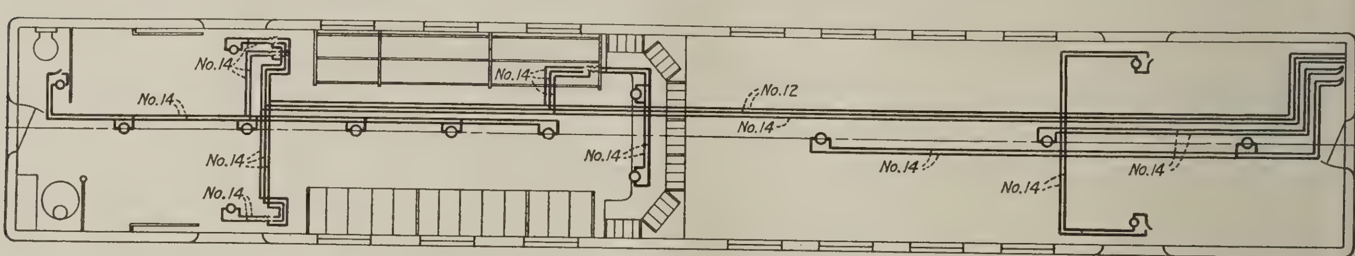


Fig. 713

705—Mail Car Lighting

The proper illumination of mail cars is of prime importance. The work of handling mail en route and at stations calls for the continuous and arduous use of the eyes of the postal clerks, and it is necessary that the illumination provided be of ample quantity, and arranged in such a manner as to allow of its continuous use without causing eye strain or fatigue.

In 1912 the Post Office Department in co-operation with some of the railroads and manufacturers made a series of tests in a car of the Baltimore and Ohio Railroad at Washington to determine the proper amount of illumination for postal cars and the limitations necessary in the installation of the means of obtaining the illumination.

As a result of these tests specifications were issued which called for certain maximum and minimum amounts of illumination in the different working zones of the car, but outside of certain rather broad limitations as to position of fixtures, the railroad was at liberty to adopt any method desired to produce the specified amount of illumination.

Owing to the fact that glass reflectors in postal cars had been subject to considerable breakage, the metal reflector with either an aluminum or enameled reflecting surface was quite generally adopted for postal car use.

While this type of reflector gave adequate illumination, and fulfilled the requirements as to diffusion, it was not popular with the postal clerks due chiefly to the fact that as the reflector transmitted no light through it, a car with an installation of these reflectors presented a rather gloomy appearance.

In 1923 and 1924 the Post Office Department again took up the matter of Postal Car Lighting with the object of revising the specifications by the incorporation of such changes as experience had indicated as desirable. Appendix A gives the revised lighting specifications as issued March 27, 1925.

As regards illumination the changes have been to very materially increase the requirements as is indicated by the following:

Table 5

Location	Minimum Foot Candles — 1912 Specifications		1925 Specifications
Bag Rack Portion:			
Center of car—horizontal.......	4.70	3.76	8.00
Mouth of bags, 18 in. from side of car—horizontal............	2.50	2.00	4.00
Letter Cases:			
Over table—horizontal..........	4.70	3.76	10.00
Face of cars—vertical...........	2.08	1.66	6.00
Storage portion	2.50	2.00	4.00

In connection with the 1912 specifications, two sets of values are given. The higher values are for use with reflectors having a glazed surface such as porcelain enamel, and the lower values for reflectors having proper diffusing surfaces. The comparison of the old and new values should be made between the lower old values and the new values, as the present specifications are based on the use of opal glass reflectors with a diffusing surface.

The new specifications in addition to specifying the amount of illumination to be obtained state rather definitely how it is to be obtained. The amount of illumination required is given in paragraph (e), the type of reflector and the size and type of electric lamp is given in paragraph (i) and paragraph (k), and while no definite arrangement is specifically required, paragraph (j) describes an arrangement which will be accepted by the Post Office

Department as fulfilling the illumination requirements of paragraph (e), and it is therefore probable that this arrangement will be closely followed by the railroads in placing fixtures in postal cars and apartments.

As the one objection to the use of glass reflectors was breakage, particularly in the storage portions of the car, the specifications allow the use of metal reflectors in these locations, with the fixture placed as near the ceiling of the car as possible; paragraph (i) and (j).

Local lighting is required over all doors, and at the lavatory; paragraph (h).

Reflectors.—It will be noted, paragraph (i) that reflectors of opal glass are required for bag rack and letter case locations and are optional for the storage sections. There was some tendency towards the specification of enclosing glass for postal cars, but it was decided that on account of the difficulty of keeping such glass clean, and the fact that the conditions of operation of postal cars is such that the lighting installation must be of the highest efficiency so that it may be operated with the least possible current consumption; the open mouth type of reflector should be used. A reflector of this description, which is in use to a considerable extent in postal cars is shown in Fig. 704.

For the side door lights and lavatory lights a metal pear-shaped reflector is used, paragraph (i) and (j).

For the storage sections metal reflectors are also approved; paragraph (i) and (j). A porcelain enameled reflector of the RLM type is most suitable for this location. Such a reflector is illustrated in Fig. 705.

Figs. 706-709 give the locations for the fixtures in 70-foot and 60-foot postal cars, and 30-foot and 15-foot mail apartments which will be accepted by the Post Office Department as fulfilling their specifications.

Circuits, Wiring, Fuses, Switches, etc.—In addition to the specifition having directly to do with illumination, the new specifications call for certain standard arrangement of circuits and switch positions; paragraphs (m) and (n). Briefly, these paragraphs call for independent control of center lights, letter case lights, and door lights in all cars and apartments, and for the location of switches to render them most accessible. The lavatory and door lights must be available for lighting when the clerk opens the side door.

Fuses are required for all circuits, which may be installed in a cabinet located on the lavatory partition in apartment cars or at the regulator locker in full postal cars, or they may be located at the circuit switches. Figs. 710-713 show a method of wiring which fulfills the specifications in all respects, and seems to be the most economical arrangement. The general plan is to provide a switch at the specified location with the proper connection for energizing the lamp regulator when the switch is closed. The fuses, with the exception of those for the center light circuits in the 60-foot and 70-foot cars are placed at the circuit switches to save running all the circuits back to the far end of the car.

Battery Capacity.—The specifications, paragraph (a), require that each mail car equipped with axle light have a storage battery of sufficient capacity to supply the normal intensity of illumination for 12 hours. The following sizes of battery are required to fulfill this specification with the layouts given here.

Car	*Capacity of battery*
70	350 A.H.
60	350 A.H.
30	200 A.H.
15	200 A.H.

This specification takes no account of the lighting for the baggage or passenger apartment of combination cars. In fixing the reserve capacity for these cars, allowance has been made for capacity in the batteries to light the postal apartment for twelve hours, and the passenger or baggage compartment for six hours. This is the practice generally adopted.

PROGRESS REPORT OF COMMITTEE ON SELF-PROPELLED VEHICLES

Committee:—

E. Wanamaker, electrical engineer, C. R. I. & P. R. R., Chicago, Ill.; E. S. Macnab, engineer car lighting, Can. Pacific Ry., Montreal, Que.; T. A. Johnston, electrical engineer, Central Ry. of Georgia, Savannah, Georgia; L. L. King, electrical engineer, A. T. & Santa Fe R. R., Topeka, Kansas; J. C. McElree, electrical engineer, Missouri Pacific R. R., St. Louis, Mo.; R. G. Gage, electrical engineer, Canadian National Rys., Montreal, Quebec, chairman.

To the Members:

Owing to the exceptional activity in the development of unit motor cars, on the railways of this continent during the last year, the members of your Committee have been unable to give the time to the preparation of this report, which the subject warrants. Failing this, we ask you to accept this short memorandum as an indication of the advances that have taken place since our last report.

Perhaps about the most noticeable single feature is the increased tendency towards the electric drive in rail cars, as well as in motor busses, and the strong consideration that is being given by the American and Canadian Railways to the question of developing an oil-electric locomotive to supersede steam in switching service.

Under the heading of unit cars might be mentioned the following:

The Westinghouse Brill 60-foot car, using a six-cylinder gasoline Brill-Westinghouse 250 hp. engine, direct connected to a Westinghouse, differentially compound wound generator, the whole car weighing about 88,000 pounds. The control is a combination throttle and generator field. There are two motors of 140 hp. mounted on the front truck and arranged to be connected in series or parallel, the motor arrangement being controlled by push buttons, through the agency of unit switches. The car is designed for double end control, with the throttle operated mechanically, a rod connection being carried underneath the car body to No. 2 end.

The G. E. Brill car using a 200 hp. six-cylinder Sterling gasoline engine, direct connected to a differentially wound G. E. generator, the whole being very similar to the control and equipment of the Electromotive Company. In the Brill car, however, the power plant is located on the car axis, instead of transversally.

The Ford car, which is being built by the Pullman Company, is about 80 feet overall, having the entire floor space available as seating capacity. The power plants consist of two 100 hp. Hall-Scott, six-cylinder gasoline engines, each direct connected to a differentially compound wound Westinghouse generator, both sets being suspended from the car underframe and located side by side immediately behind one of the trucks. There are four motors, two on each truck and arranged so that each pair can be connected to either generator, ordinarily one pair of motors is driven off each generator. The two generators are entirely independent but are controlled in parallel from a single master controller. Motors are connected permanently in parallel and the car speed is changed by the control of the generator field, the speed of the engine being constant.

The Rock Island have electrified some of their McKeen gasoline cars by installing the Electromotive Company's power plants and control.

The oil-electric cars built by the Canadian National Railways at Montreal, consisting of the articulated type, with 126 seating capacity, equipped with 340 hp. eight-cylinder Beardmore oil engine, connected through a Fast coupling to a Westinghouse differentially compound wound generator. The car speed is attained by generator field control, two motors being mounted on each of the forward and rear trucks, the four motors being permanently connected in parallel. A 300-volt battery is utilized for generator field excitation, starting the engine by motoring the generator and for propelling the car in case of power plant failure.

The second oil-electric car is of 60-foot overall length, with a total seating capacity of about 57. The power plant consists of a four-cylinder Beardmore oil engine, direct connected to a British Thompson-Houston differentially compound wound generator and exciter. Two G. E. motors are mounted on the front truck and are arranged for series, parallel and shunt field connections in the forward direction and series and parallel connections, reverse. The car speed is attained by throttle control from either end, by means of direct mechanical connection to the engine throttle, continuous, cable and pulleys being used to reach No. 2 end. A 120-volt battery is used for engine starting and control. One of the principal features in these oil engines is their excessively light weight of 14 pounds per brake horsepower as against 50 to 80 pounds per brake horsepower in other engines.

Under oil-electric locomotives can be mentioned—

The Baldwin-Westinghouse 130-ton locomotive, utilizing an Inverted V Twin Six Knudson engine, 450 r.p.m., developing 1,000 hp., which is geared to a Westinghouse compound wound generator, running at 1,200 r.p.m. There are four motors, two on each truck. The control is electro-pneumatic and consists of a combination of throttle and field control. The motors are arranged for series or parallel operation.

The Ingersoll-Rand locomotive, 100 tons, consists of two of the 300 hp. plants, previously developed.

The Brill 60-ton locomotive consists of two of their 250 horsepower gasoline electric plants, utilizing four motors, two on each truck. The control is similar to the Pullman Hall-Scott car and is of the generator field type, the engine being of constant speed.

The Pennsylvania 65-ton locomotive utilizing one 500 hp. oil engine, connected to a Westinghouse differentially compound wound generator. This will be a rigid wheel base, single truck locomotive with one motor on each axle.

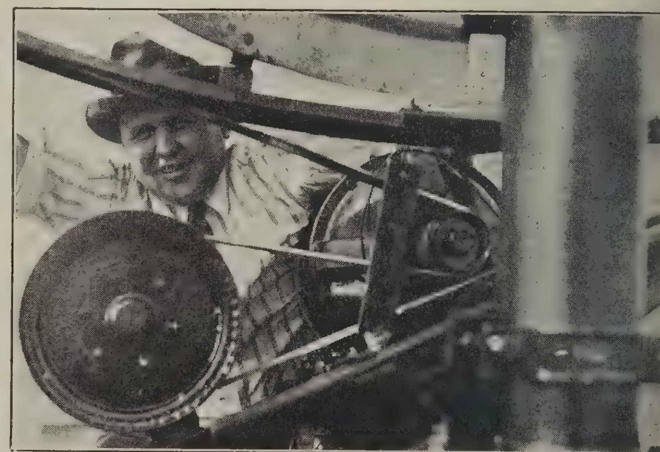
Wind Mill Driven Alternator on Great Northern

Electricity developed by a specially constructed windmill is being used to operate automatic block signals on a 26-mile stretch of track on the Great Northern at Culbertson, Wyoming. It is planned to extend this service for signal operation between Wolf Point, Montana, and Williston, North Dakota.

In adapting the turbine idea to the signal system a

General Appearance of the Installation

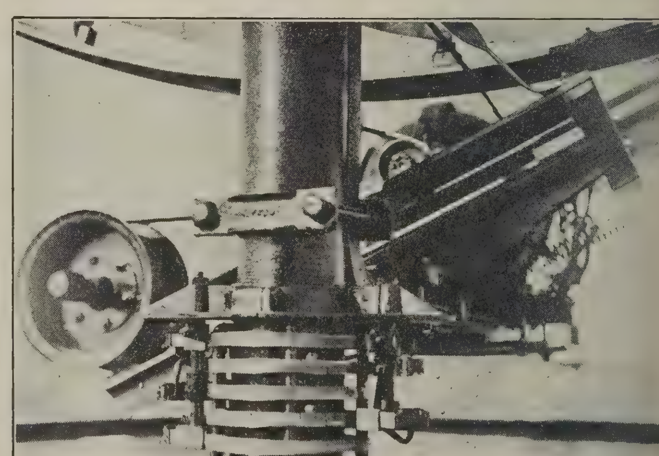
specially designed alternating current generator delivering 60 cycle current had to be developed. Generating direct current by wind turbine is comparatively easy. To generate alternating current calls for careful speed regulation. A special governor, however, has made this possible. Not only does the governing system on the wheel keep the speed constant, but it also lessens the area exposed to the wind in storms. This furling of blades is operated by a centrifugal governor located in the wheel. Under this system the blades of the wind turbine are automatically changed in regard to the area exposed to the wind. The stronger the wind, the more the blades are turned from the wind and the less area is exposed to wind



The Belt Arrangement Allows Ample Contact Surface on the Generator Pulley.

action. This feature makes this windmill safe in storms and allows the wheel to develop great power with safety.

The wheel itself is 14½ feet in diameter. A belt sheave is mounted over the periphery. This sheave takes a weather-proof belt, which travels over the generator pulley, over an idler, and back to the sheave. The generator is easily accessible as it is located directly below



Through Collector Rings the Current Is Led to the Circuits

the wind wheel. The drive is highly efficient, allowing the wheel to generate even in very light winds.

The tower at Culbertson is 62 feet high and rests on concrete anchors. It weighs about 6,000 pounds and required two weeks to erect complete. Five collector rings are a part of the control of the generator. From this equipment the company gets 220-volt alternating current, 30 and 60 cycle, and 325-volt direct current. The windmill complete was furnished by the Wind Electric Company, Minneapolis.

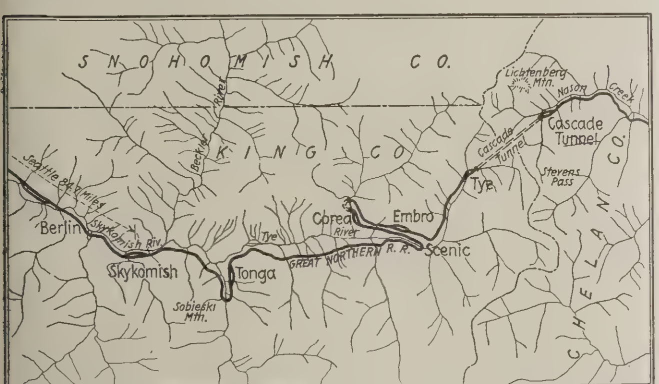
Great Northern Electrification

Motor-Generator Locomotives Will Be Used on 24-Mile Heavy Grade Section Including the Cascade Tunnel

By E. Marshall
Electrical Engineer, Great Northern Railway Company

THE recent announcement by the Great Northern of its intention to electrify 24 miles of main line on the west slope of the Cascade mountains, extending from Skykomish to Cascade tunnel, Washington, again turns the attention of the railway field to activities in the Northwest. Interest in the undertaking is much increased by the decision of the management to adopt as the motive power unit the motor-generator type of locomotive and the fact that one of the original electrification projects in this country, the three-phase system through the Cascade tunnel, is to be retired to give place to the new work.

By eliminating the duplication of helper service, the delays caused thereby, and other losses of time incident to the operation of steam locomotives, such as watering, refueling, etc., the electrification will effect a substantial reduction in operating expenses, permit of faster train movement over this section, and fulfill, in every way, the requirements of present operating conditions. Consideration has also been given to future requirements by an ample allowance for expansion; and by its willingness and desire to materially assist in the development of a new type of locomotive, the Great Northern gives evidence of a keen interest in the future of electrification, as a means of solving transportation problems of the country in general, as well as its own.



Map Showing Location of Section to Be Electrified

The main line of the Great Northern extends from St. Paul to Seattle. Of the freight traffic, a large portion is a through traffic, originating at one of the mentioned cities and, as such, requires a fast and reliable train service, which the company is well fitted to provide, having the least ruling grade to the coast of any of the western railroads, and an enviable roadbed, laid with heavy steel and double tracked at most of the critical points. The heaviest curves and grades against load movement are encountered in crossing the Cascade mountains in Washington, over what is yet a single track line. Here the rise to the summit is, on both sides, very precipitous, and on the west slope a very circuitous route is required in making the ascent. Many snow-sheds protect the track from winter slides, and, in several places, the mountain has been pierced with tunnels, the longest of these being the Cascade tunnel at the summit of the range. This tunnel, constructed on a 1.7 per cent grade, is approximately 2¾ miles long and the present electrification was installed through the tunnel in 1909 for the purpose of eliminating gas and smoke.

Present Electric Equipment

Extending between Tye, the west portal, and Cascade tunnel station, the east portal, the existing electrification comprises four miles of main line track and an equal amount of yard trackage, equipped with a double overhead three-phase trolley of 6,600 volts. The present locomotive equipment consists of four, three-phase, 25-cycle General Electric units, as follows:

Total weight of unit	227,000 lb.
Classification of wheels	0-4-4-0
Weight on drivers	227,000 lb.
Number of driving axles	4
Capacity at one hour rating	1,300 hp.
Capacity continuous rating	1,300 hp.
Max. starting tractive effort	37,500 lb.
Tractive effort, continuous	25,000 lb.
Speed	15 m.p.h.
Total length wheelbase	31 ft. 9 in.
Rigid wheelbase	11 ft.
Length over-all	44 ft. 2 in.
Width over-all	10 ft. 2 in.
Maximum height (trolley down)	15 ft. 6⅝ in.
Diameter driving wheels	60 in.
Gear ratio	4.26
Method of drive	Gear and pinion
Number and type of motor	4 G. E. I—506
Voltage of motor	500

At the time this installation was made, there were no electric power lines within an available distance and to meet the situation the railway company was obliged to build a hydroplant at Tumwater on the Wenatchee river, 30 miles east of the tunnel. In this plant are three 2,000-kw. three-phase 25-cycle, 6,600-volt hydro-generators, operating under a head of 176 ft. and obtaining the water through an 8½-ft. flume, 2½ miles in length. The power thus furnished is transmitted to the sub-station at Cascade tunnel over a 33,000-volt transmission line.

Though serving the purpose for which it was installed, and relieving an almost impossible condition under steam operation, the necessity of maintaining a special tunnel organization has resulted in extremely high operating cost, and thus this electrification has long been tolerated as a necessary evil.

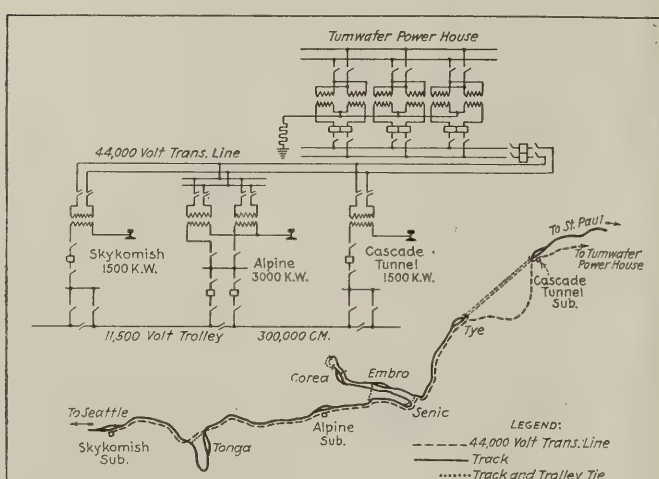
Between Seattle and Skykomish the condensed profile shows that the grades are not unduly heavy, nor are the curvatures excessive, the heavy grades and curves being confined to that section on the west slope of the Cascade mountains, between Skykomish and Cascade tunnel and, on the east slope, between Cascade tunnel and Leavenworth. With conditions on the east slope the railway is not especially concerned at this time, as certain contemplated changes in line with other reasons, have for the

present delayed the electrification of that side. On the west slope, however, a consistent grade of 2.2 per cent is encountered from Skykomish to Tye, a distance of 21.4 miles, with curvatures up to 10 degrees, and from Tye to the summit of the range, through the Cascade tunnel, the grade is 1.695 per cent.

East and west bound traffic, over this section each day is very similar, consisting each way of two passenger trains of about 1,000 and 850 tons, one express and mail train of 600 tons and a minimum of two time freights of 2,500 tons, none of these weights including locomotives.

Steam Operation

A 2,500-ton time freight, out of Seattle, or rather Interbay, the terminal yard, consisting of about 60 cars, covers the 80 miles to Skykomish in approximately 5½ hours when hauled by a 250-ton Mikado type 2-8-2 oil burning locomotive having a normal tractive power of 64,300 lb. At Skykomish, two 2-6 + 8-0 mallet type locomotives of 260 tons and developing a tractive effort of 78,300 lb., are cut into the train at about uniform distance apart, to assist on the 2.2 per cent grade to Tye. Including a delay at Skykomish for this operation of one hour and for water at Scenic of 20 minutes, the 21.4 miles to Tye is covered in 4½ hours. On arrival at Tye, the steam helpers are replaced in 30 minutes by the electric locomotives, located two ahead and two in the center of the train, and from Tye, the run to Cascade tunnel station is made in 22 minutes. Allowing 15 minutes at Cascade tunnel for cutting out the electrics and inspecting air



Wiring Diagram Showing Power Connections and Location of Transmission and Trolley Lines

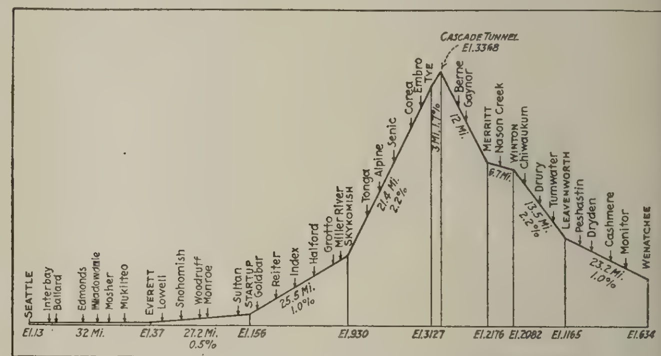
brakes, the train when reassembled completes the remaining 53 miles to Wenatchee in four hours.

Reasons for Adopting New Type of Electric Equipment

Realizing, as shown in the foregoing review of the operation, that a considerable improvement could be made in the schedule and a substantial reduction in the operating expenses, the management authorized the necessary appropriation for an electrification to accomplish the desired results. The authorization provided for a new system of electrification, as all concerned were acquainted with the fact that it would not be advisable to extend the present system.

The straight three-phase system, though used extensively in Italy and Switzerland, is not a highly desirable type of electrification, chiefly from an operating standpoint, but, as the general reasons for this are well known, reference will be made here to those only which are more distinctive to the operation on the Great Northern. First of these is the relatively low power factor of the system, and, second, the excessive power required during periods of train acceleration.

In the case of the former, without power factor correction on the line, the useful power at the locomotive is but little more than half of the kw. output of the station and, therefore, has been insufficient to pull the



Condensed Profile of Western End of Great Northern Lines, Including Section to Be Electrified

present large trains, requiring the four locomotives, at the rated speed of 15 m.p.h. To somewhat relieve this condition, the motor connections were arranged, a short time ago, to permit of operation at 7½ m.p.h. with the motors connected in "cascade," or at 15 m.p.h. connected in multiple. But, even with this change, the enormous starting current required by a three-phase motor makes the assistance of the steam locomotive necessary in accelerating the train, as the flow of the water in the 2½-mile flume is not sensitive enough to load variation to meet the excessive demand placed upon the station when starting without the steam helper.

The experience, both favorable and unfavorable, gained from the present electrification, proved invaluable to the company in selecting the system to be used on the new work with the result that the one adopted, comprised of a motor-generator type of locomotive, taking power from a 11,000-volt trolley, will unquestionably be more flexible than any system in operation at this time.

The inherent economy in transmission and operation of the high voltage trolley system, with its static non-attended transformer sub-station, minimum amount of copper, general lightness of supporting construction, and ready adaptation to increase in loading conditions with increase in traffic is today generally recognized; and in this case the lightness of the overhead construction is of special value. In the snowshed and tunnel district, this will appreciably lessen the difficulties and cost of construction, and during the period of annual snowshed repairs will aid greatly in maintaining uninterrupted service, when at times the trolley must be removed and replaced between trains.

With limitations existing, for the present, in the power supply, it will always be possible, with the flexibility of control of the motor-generator locomotive, to operate at a practically unlimited number of speeds, up to that of the continuous rating of the locomotive. Furthermore,

the method of accelerating a train by means of voltage control of the motor is ideal from the standpoint of economy, both in starting losses and in power demand from the sources of supply and by using a synchronous motor to drive the main motor-generator set power factor correction is obtained, thereby making practically the entire output of the station useful power.

In regeneration, the same flexibility of control is obtained as in motoring, it being possible to regenerate at all speeds within the range of the locomotive to practically standstill. The varying train weights over this section, and the conformation of the country, makes this large range a very desirable feature, as the speed, while regenerating, can always be adjusted to conform to the traffic requirements on the particular section of track.

The new locomotive will consist of four identical cabs as to size, weight and traction equipment, though for the present two only will be furnished with motor-generator sets; the other cabs will be connected to, and obtain their power from them. It is interesting to note that because of the large range of speed obtainable by varying the voltage of the traction motors through the main field of the main generator, there will be no need of a variety of motor connections and therefore the motors of each cab are to be connected permanently in parallel with the exception that the motor cutout switches through the two cabs, when operating together, will be connected in series.

Electric Locomotives

The tentative characteristics of each cab are as follows:

Total weight (approx.)	340,000 lb.
Weight on drivers	260,000 lb.
Classification of wheels	2-8-2
Length rigid wheelbase	16 ft. 9 in.
Length total wheelbase	30 ft. 3 in.
Length over couple knuckles (approx.)	48 ft. 8 in.
Length of cab (approx.)	42 ft. 0 in.
Number motors	4
hp. motor (continuous)	500
Voltage of motor	600
Diameter driving wheels	56 in.
Tractive effort (continuous)	44,000 lb.
Max. speed at about tractive effort	15.2 m.p.h.
Max. allowable speed	35 m.p.h.
Continuous capacity, m. g. set	1,500 kw.

To obtain the benefit and use of the present three-phase locomotives, a synchronous phase converter, similar to those being furnished on the Virginian Railway, will be mounted with the necessary auxiliary apparatus, transformers, etc., on a car between two of these locomotives; but as the car will not be equipped with traction motors, will serve as a trailer or tender car. Connection to the trolley will be made from the pantagraph mounted on this car and with practically no change in the present control the locomotives will be capable of duplicating their present performance.

Power Supply

The Tumwater plant, operating single phase, is, for a short period, to furnish all the power for the electrification and it is interesting to note that practically the full capacity of the generators can be obtained under this operation, without imposing any undue stresses on them, while present day machinery designed on a much closer margin can only be worked single phase to about 70 per cent of its three-phase capacity. In general, very little change in the plant will be necessary, excepting a rearrangement of the transformer banks.

To furnish three-phase power at 33,000 volts, each transformer bank, at present, is composed of three 6,600 to 19,000-volt single-phase transformers with secondary windings connected in star. The change will consist of using six of these transformers, connected in pairs, to the single-phase transmission line and, as shown in the wiring diagram, the transformers in each pair will have their primary windings connected in parallel and their secondaries in series.

The power thus obtained at 38,000 volts will be transmitted to the sub-stations at Cascade tunnel, Alpine and Skykomish, where the stepdown transformation will be made to 11,000 volts for the trolley. Cascade tunnel substation is an indoor station and is to be changed only as regards the switching arrangement and the replacement of the present transformers with a new one of 1,500 kva. capacity. The two new stations at Alpine and Skykomish will be of the outdoor type and will have for the present a capacity of 3,000 and 1,500 kva. respectively though each of the three stations will be so arranged that their capacity may be increased at any time.

Contact System

The trolley system will consist of a simple catenary with inclined catenary on the curves, all of which is to be constructed with non-ferrous materials and to obtain the necessary strength and conductivity of 300,000 c.m. equivalent copper, a 19-strand composite messenger and a 4/0 high strength cadmium bronze contact wire will be used.

Around the Tonga and Corea loops this heavy construction is not required as it is possible to tie the tracks and trolleys together at various places as shown in the diagram. In these sections the messenger will consist of a 4/0-19 strand high strength cadmium bronze messenger and 4/0 contact wire of like characteristics.

Wood pole structures will be used for supporting the trolley, excepting through the snowsheds and tunnels, where the suspension will be made direct from the roof. The power transmission and signal transmission lines will also be carried on the trolley poles.

Operation over the electrified section is to commence June 1, 1926, and to that end the installation is being pushed as much as possible. The program of construction consists of placing all the pole structures this year and the wire and apparatus as soon as the snow conditions will permit next year.

As a whole, the electrification constitutes an important engineering development, but to the Great Northern the chief significance is of an economic nature. Much is expected of the change and the rigorous conditions under which operation is to commence will test the merits of the system, as perhaps none has been tried before. Freight train time over the division will be shortened an hour and a half, the wear on the rolling stock, especially in descending grades, will be reduced to a minimum, track capacity will be considerably increased, and the operation of smokeless passenger trains will permit the passengers to enjoy to the fullest one of the most scenic spots in America.

Few industries have equalled the record of the electrical industry in promoting a uniformity which enables it to give a maximum of service at a minimum of cost. Interchangeability of lamp bases, greater uniformity in voltages, and in a number of other directions this has been a notable achievement.

A Virginian Locomotive in the Yards at Mullens, W. Va. Aerial Can be Seen on Roof of Second Cab

Electric Operation Begun on the Virginian

Communication Between Front and Rear End of Train Made Possible by Adoption of Wired Wireless System

ELECTRIC operation on the Virginian was formally inaugurated on Monday, September 21. Tonnage trains are now operated electrically from Mullens, W. Va., up a 2.07 per cent eastbound grade to Clarks Gap, W. Va., a distance of about 15 miles. The overhead catenary has been completed to a point about two miles east of Princeton, W. Va. Princeton is 36.5 miles east of Mullens. Four electric locomotives have been delivered and at present these are used only on the grade between Mullens and Clarks Gap. The complete order for locomotives includes 10, three unit and 6, single unit locomotives. The single units will be used for pick-up and switching service.

A Close Up View of the Antenna

Operation

Under steam operation a train weighing from 5,500 to 5,700 tons is taken up the grade by a 2-8-8-2 road locomotive and two 2-10-10-2 pusher locomotives at a speed of about 7 miles an hour. The pusher locomotives are the heaviest steam locomotives ever built and weigh in working order (including weight of tender) 898,300 lb. The weight of the road engine and tender in working order is 740,100 lb.

With electric operation one road engine and one pusher are used. A number of trains, some weighing a little less than and some slightly more than 6,000 tons net have been taken up the 2.07 per cent grade by two electric locomotives at 14 miles an hour without exceeding the maximum allowable temperature rise of the motors. Each locomotive weighs 1,274,000 lb. and is normally rated at 7,125 hp. During acceleration a total of 20,000 hp. is applied to the train. Surprisingly little difficulty has been encountered in the operation of these trains. They are made up for the most part of Virginian cars of 218,000 lb. capacity and the average load per car as measured over the scales at Norfolk is 116 tons. Each car empty weighs 40 tons.

Nearly all of the heavy tonnage movement on the Virginian is eastbound coal and from the eastern end of the electrified section, trains will be hauled to tidewater by steam, in accordance with present practice. The grade favors traffic practically the entire way and electric operation is at present unnecessary.

Power Supply

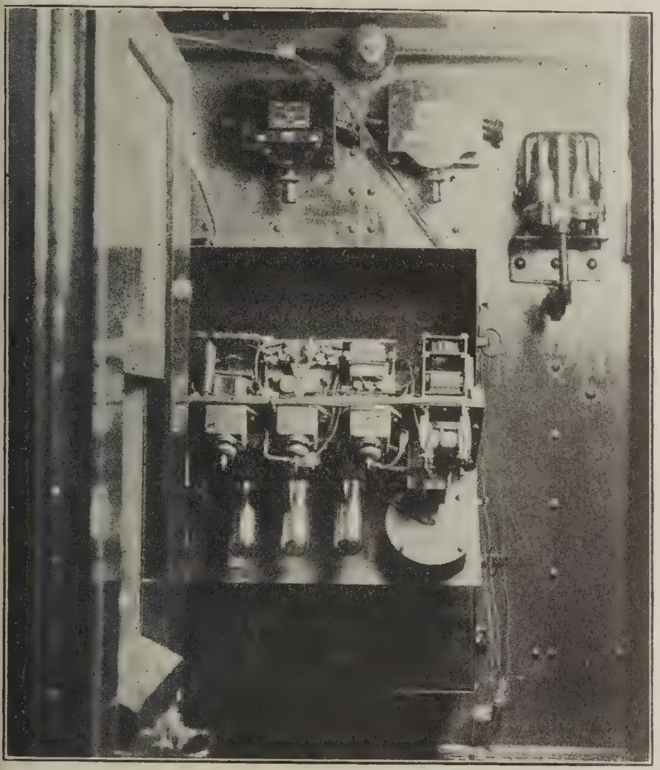
Power for the electrified section is supplied by the railroads own power house located on the New River at Narrows, Va. It has a capacity of 80,000 hp. There are four turbine driven generators of 15,000 kw., normal, but three are sufficient to carry the maximum demand of the railroad. The transmission line and overhead catenary construction are of the non-corrosive type. The power house and substations are of unusually substantial construction. A shop for service of the electric locomotives is being completed at Mullens.

The locomotives were built by the Westinghouse Electric & Manufacturing Company and the American Locomotive Company. The overhead construction was erected by Gibbs & Hill, designing and construction engineers.

Signal System for Long Freight Trains

Wired wireless for communication between the front and rear end of long freight trains on the Virginian has been developed by the Westinghouse Electric & Manufacturing Company.

There is very little tangent track on this section and there are a number of tunnels so that at very few points is it possible to see one end of the train from the other. In order to compensate for these conditions and at the same time facilitate the difficult task of handling so heavy a train, two of the locomotives have been equipped with a wired-wireless communicating system. The apparatus is now in an experimental stage, but may later be adopted as regular equipment.



Transmitting Tubes and Equipment

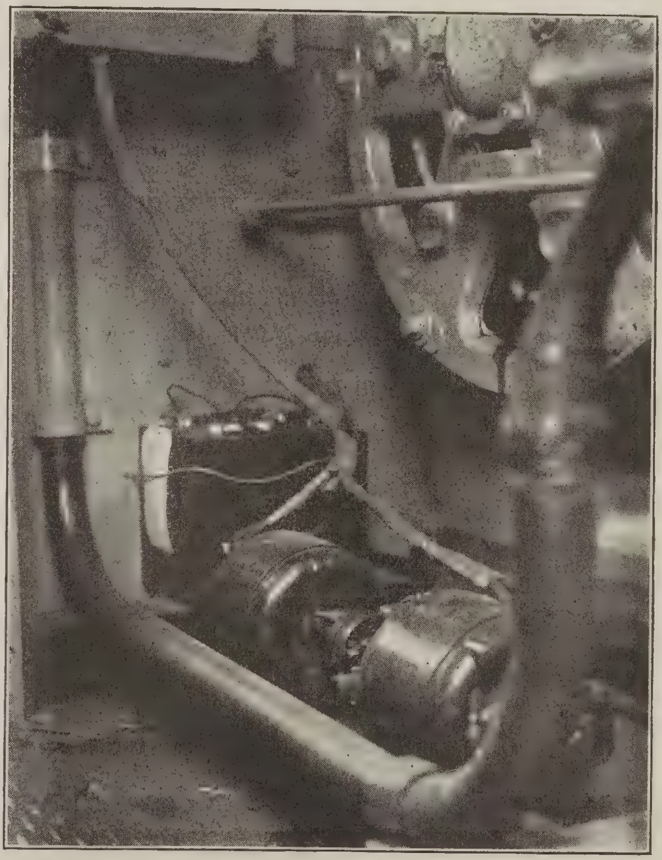
The apparatus consists essentially of a standard radio sending and receiving set, located in the number two cab on each locomotive and connected to a short aerial on the roof of the cab. This aerial is parallel to the trolley wire and when a signal is sent out it follows the contact wire and is picked up by the aerial on the other locomotive. Practically all of the energy emitted from the transmitting aerial follows the trolley wire.

Two kinds of signals can be used, namely, howler and telephone. At present only the howler signals are used in the locomotive cabs. In each cab there is a control box and a horn or loud speaker. A short piece of rope hangs out of the control box and when this is pulled it causes a howl or whistling sound to come out of the horn in the other locomotive cab. Regular whistle signals are used. If telephone communication is desired as the system is now installed, it must be carried on from the middle locomotive unit. In its present state of development, the telephone works well when the train is standing still but not when the train is running. No such difficulty is encountered with the howler. Consideration is now being given to the possibility of using similar apparatus on steam locomotives using wayside wire lines or running rails as carriers.

Type of Equipment Used

The transmitter consists of a short wave oscillator, modulated by a 500 cycle tube oscillator. It contains three 50-watt transmitting tubes, two of which are used as modulators and one as a radio frequency oscillator. The circuit used is a Harvey circuit with antenna choke coils. There are two control dials. The number 1 dial controls the antenna circuit and the number 2 dial is a master controller which determines wave length. A change-over switch is used to cut out the howler circuit and permit telephone communication. The radio frequency used can be varied from 110 to 140 meters.

The receiver circuit is similar to that used in the Aeriola Senior broadcast receiving set. The amplifying transformers are wound to have a peak at 500 cycles. Three 201A radiotrons are used in the receiver. Both the transmitting and receiving sets are tuned and locked. The two are contained in one metal cabinet, 28 in. wide, 30 in. high and 8 in. deep.

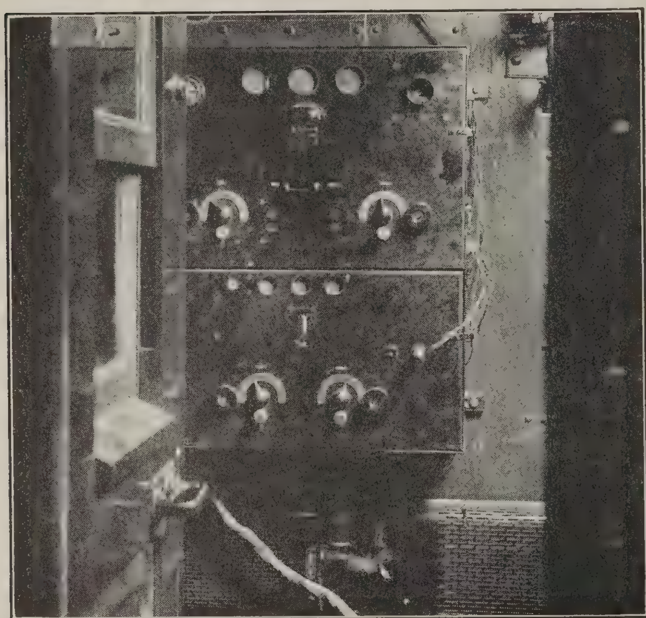


Motor-Generator Set and Storage Battery

Power for operating this set is obtained from the 32-volt battery which operates the locomotive control circuits. The filaments of the three transmitting tubes are connected in series to this battery. At present a 6-volt

battery is used for lighting the 201A tubes in the receiver. Eventually this battery will be disposed of and current will be taken directly from the 32-volt battery.

High voltage, direct current for the antenna circuit is obtained from a small motor generator set. The motor of the set is a 32-volt, 250-watt motor. It is direct connected to a generator which has two commutators and two sep-



The Signal Sending and Receiving Set

arate windings. One commutator provides 80 volts for the excitation of the generator field and the other provides 1,000 volts for the antenna circuit. The set is mounted on a base 20 in. long.

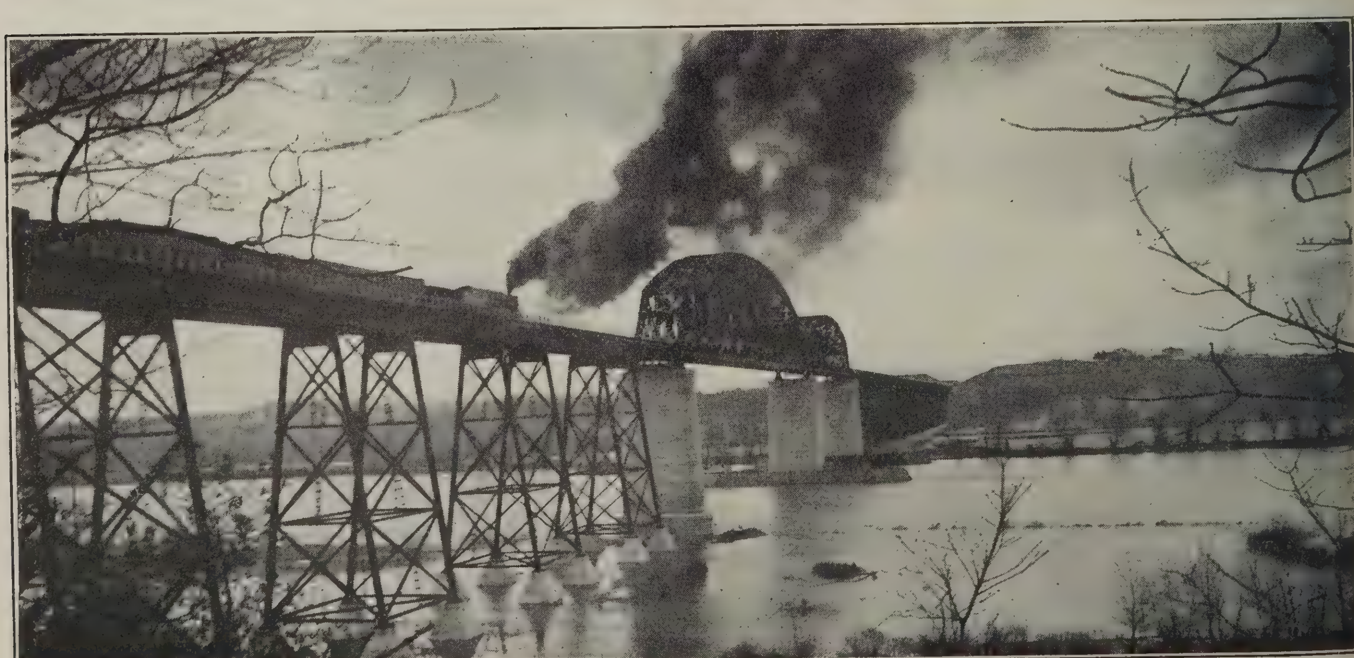
The control box, mounted in the engineman's cab measures 10 in. by 5 in. by 3 in. It contains a contact arm held up by a spring. The operating rope is fastened to the end of this arm. Pulling the rope slightly causes a contact to engage which lights the filaments of the transmitting tubes and starts the motor generator set. Pulling the rope down farther causes another pair of contacts to engage which sends out the howler signal.

The aerial mounted on the cab roof is supported on

Typical Overhead Construction Showing Low Wire Warning Sign

porcelain insulators and consists of a piece of brass tubing, 24 ft. long with an outside diameter of ½ in. The same antenna is used for sending and receiving.

The apparatus was designed and built by the radio engineers of the Westinghouse Electric & Manufacturing Company.



Heavy Freight Train Passing Over New York Central's Castleton Bridge

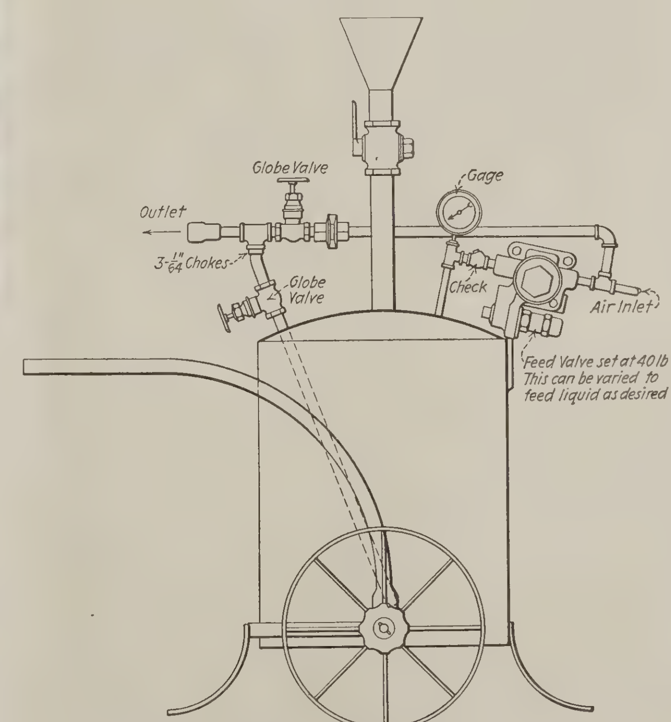
Frame Washer for Electric Locomotives

A special type of frame washer designed for use on the frames of electric locomotives has been developed in the Chicago, Milwaukee & St. Paul shops at Deer Lodge, Mont. The washing machine usually used with steam locomotives is not satisfactory for certain types of electric equipment on which the motors hang in such a position that water might enter and injure them.

The Washer in Service

The machine consists essentially of a drum fitted with pipe connections, a reducing valve, a gage, two globe valves, a filling cock and necessary hose connections, all mounted on a two-wheel truck. Air pressure forces the washing liquid upward through the pipe which extends to the bottom of the drum, through the globe valve and through a choke consisting of three 1/64-in. holes. It has been found that orifices of this size control the flow of the liquid sufficiently without other regulation. On a similar machine built previously, a feed valve was used, which is now done away with. The purpose of the feed valve was to carry various air pressures to further regulate the flow of the liquid but it has been found that with the three 1/64-in. holes, the pressure on top of the liquid provides about the right amount of spray.

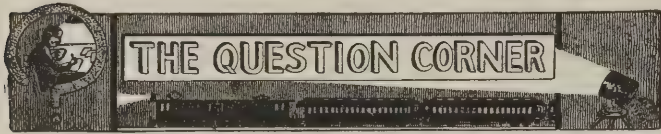
The machine is operated as follows: The valve is closed on top of the tank and the valve on the air pipe is opened, allowing the shop air to flow through a convenient length of hose being used at the point marked "Outlet." The air passes through the outlet and through the hose and finally out of a nozzle which is made of a short piece of pipe flattened at one end, the nozzle has an opening which is 1¼-in. long by 3/64-in. wide. The air blast is first used to blow the dust from the frame after which the valve at the top of the tank is opened and the air pressure on top of the liquid causes the liquid to flow up to the tee just ahead of the air regulating valve where it becomes mixed with the air which is blown on the frame. This cuts the dirt sufficiently so that after one section of the frame has been treated with the solution the liquid is again shut off and the liquid and accumulated dirt blown free from the frame. With this arrangement no waste is used and the only other cleaning necessary is at points where free oil may have collected. The free oil is taken off with a little kerosene put on with a paint brush.



Side Elevation of the Washer, Showing Form of Construction

By this method, one man can clean both sides of the frame of an electric freight locomotive in two hours time. Before the washer was used it took five laborers the same length of time, the laborers using about 20 lb. of cotton waste and two gallons of kerosene for the job. The solu-

tion used in the washer consists of one pint of kerosene or mineral seal oil and 1 lb. of soap to each gallon of water. This mixture is boiled thoroughly before being put in the washer and the solution when made up costs about three cents a gallon.



Answers to Questions

1.—*In a three wire return loop system, such as is employed on the train lines of car lighting work, do all of the cars of the train receive the same voltage?*

Voltage Drop in Train Lines

For the sake of simplicity, the criss-crossing of the train lines in the diagram in both the cars and the train line connectors is omitted, and each car is represented by a circle. Assume a train having 10 cars back of the dynamo car, wired with No. 0000 train lines, and the lamp load on each car is exactly 10 amperes. There will then be 100 amperes generated, which will flow through the positive train line to the rear of the train, 10 amperes branching off at each car. We will also assume that the lamp current for each car is tapped off the train line at the rear of the car in each case. We will then have, as shown in the diagram, 100 amperes flowing through the positive lead in the first car back of the dynamo car. Since 10 amperes was fed to the lamps of the 1st car, there will only be 90 amperes flowing through the positive lead of the 2nd car, and since 10 amperes of this feeds the lamps of the 2nd car there will be only 80 amperes flowing through the positive lead of the 3rd car, 70 in the 4th, etc.

age drop in this positive train line would then be the current times the resistance (100 x .0070) or 0.7 of a volt. In the second car there is only 90 amperes flowing in the positive lead and 10 in the negative, so the voltage drop in the positive would be 90 times .0070, or 0.63 volts; in the negative train line of this same car, which carries only 10 amperes, the voltage drop would be 10 x .0070 or 0.07 volt. In car No. 3 the voltage drop, in the same way, is found to be 0.56 volt in the positive lead and 0.14 volt in the negative; in car No. 4, 0.49 volt in the positive, train line and .21 volt, in the negative, etc. (see diagram).

The voltage across the lamps in any car is obviously the voltage of the generator minus whatever voltage drop occurs in both positive, negative and return loop train lines leading to that car. Take, for instance, the lamps in car No. 1, we find that there is .7 volt drop in the positive lead of the first car, but as the current for this car must then flow through the negative train line to the rear of the train and through the return loop to the generator negative, the voltage drop is the sum of the drop in positive line in car No. 1 and the individual drops in the negative train line of each car, and return loop, or the sum of 0.70, + 0.07, + 0.14, + 0.21, + 0.28 + 0.35, + 0.42, + 0.49, + 0.56, + 0.63, and .7 volts drop in the return loop, or a total of 11.03 volts total drop in the complete circuit of the current flowing through car No. 1.

By following the flow of current to the middle car of the train, car No. 5, and adding the voltage drop in the train lines through which this current passes (positive train lines in cars 1, 2, 3, 4, 5 and negative in cars Nos. 6, 7, 8, 9, 10 and the return loop, see diagram), it is found that there is a total of 12.96 volts in the circuit.

And similarly it is found that the total drop for this car is 11.03 volts, the same as for car No. 1.

Now then, if the generator voltage is adjusted to 76 volts, the voltage on the lamps of car No. 1 will be 76

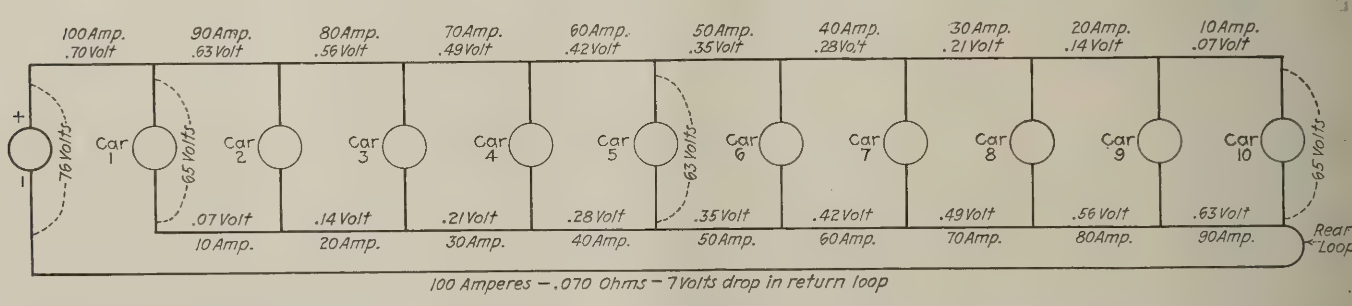


Diagram Showing Voltage Drop in Head End Train Line. The Criss-crossing of Car Wiring and Connectors Is Omitted for the Sake of Simplicity. Note That Front and Rear Car Have the Same Voltage, but the Center Car Is 2 Volts Lower

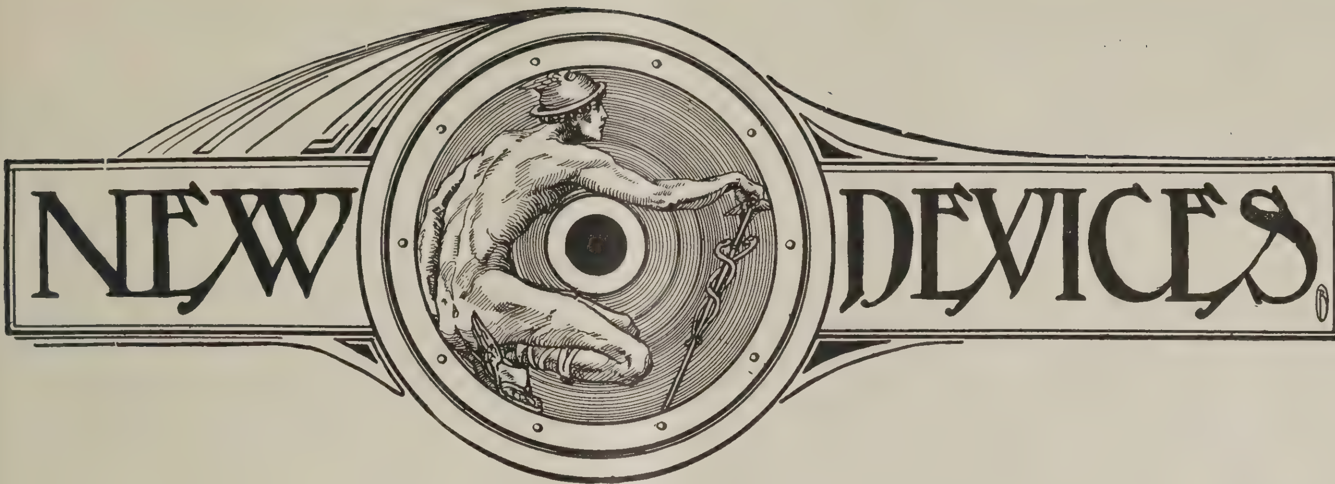
The resistance of the train line, No. 0000 stranded copper wire, is found from wire tables to be .00005 ohms per foot, or .00035 ohms for each train line in a 70-ft. car. Practical experience has shown that there is also a voltage drop in each train connector; this varies with the amount of dirt and corrosion on the copper contacts, but for the sake of simplicity we will assume that the resistance of both the contacts of the train connector is the same as the resistance of the No. 0000 train line in one car. This will make a total resistance per car of .0070 ohms for each train line, including both wire and connector.

In the first car, with 100 amperes flowing, the volt-

minus the 11 volts drop in the train line, or 65 volts; on the other hand, the voltage across the lamps in car No. 5 will be 76 volts minus the drop in the train lines to that point (12.96 volts) or approximately 63 volts; and similarly it is found that the voltage on the lamps of car No. 10 is 76 volts less the drop in train lines to that point (11.03 volts) or 65 volts, the same as car No. 1. The voltage of other cars in the train can easily be figured out.

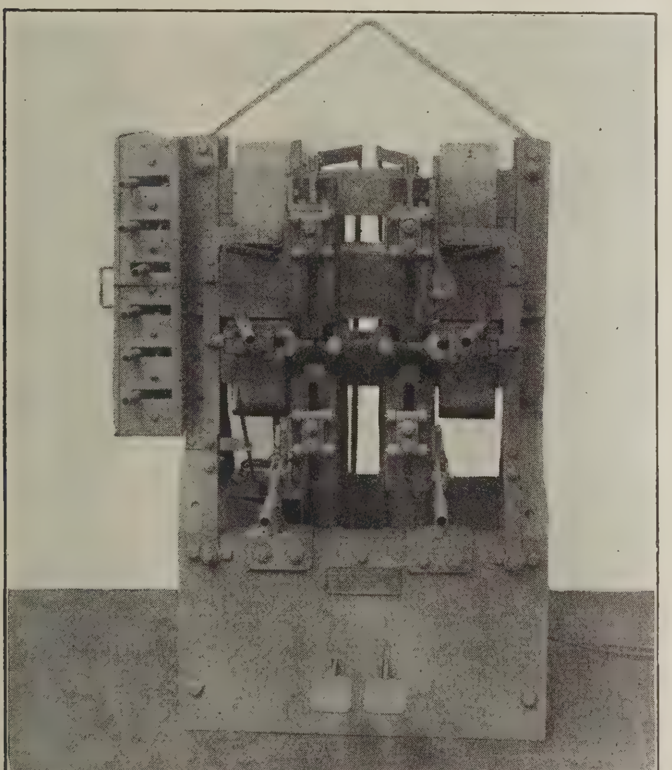
Questions for December

1. *By what different methods can you tell when a storage battery has been brought up to a full state of charge?*



Electric Rivet Heater

Three models of electric rivet heaters, all of which operate on alternating current of any voltage, have been placed on the market by the American Hoist & Derrick Company, St. Paul, Minn. Model A is a two-rivet machine with a 40-foot super-service table, and weighs approximately 1,100 pounds. Model B is a four-rivet stationary type which weighs approximately 1,900 pounds.



The Two-Rivet Electric Rivet Heater

These models are primarily designed for heating rivets for structural work. Model C is a two-rivet machine, especially designed for heating rivets for boiler work. It weighs approximately 2,500 pounds.

Model C is equipped with special adjustable side contacts so arranged that the temperature in any part of the rivet may be regulated by the operator. This arrangment enables the operator to heat the grip of the rivet to a white heat, while the end and head are kept at the proper temperature for driving, thus insuring that the rivet completely fills the holes.

The sliding jaws and the E element are of solid cast copper throughout and have thirty times the current carrying capacity of a 1-inch rivet, making it impossible to overheat the machine to a dangerous degree. They are so designed that the rivets up to and including 9 inch in length can be placed in the jaws without any adjustment and with no fear of mushrooming. The sliding jaw permits the E element to be constructed in such a manner as to tightly hug the laminated iron case—its source of power—on three sides, thus practically eliminating magnetic losses and reducing current consumption to a minimum.

All three types are equipped with interlocking heat control, conveniently located at the operator's left hand, which provides instant control of the current.

Safety Switch With Arc Quencher

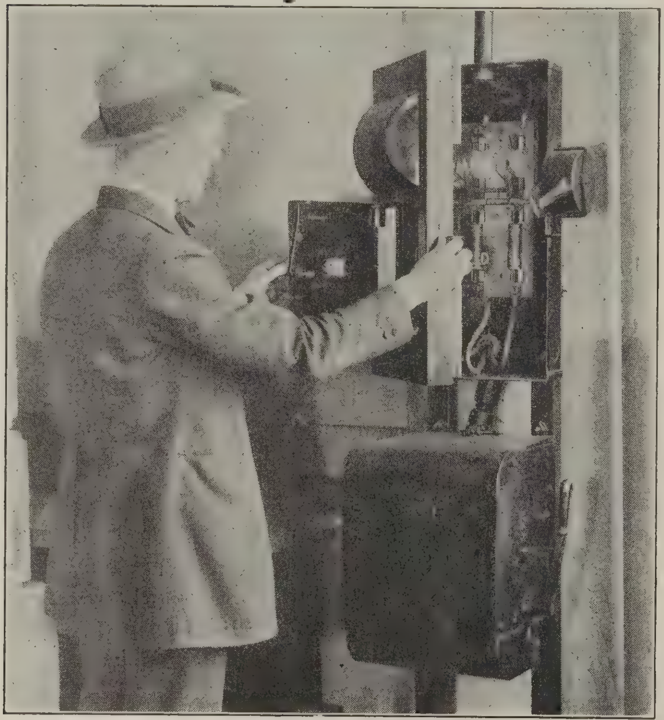
A safety switch known as the WK-55 has been introduced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., the design of which provides full safety for the operator and the motor under all conditions.

In order to eliminate the possibility of the operator coming in contact with live parts when changing fuses, the switch has been designed with a double door construction. Within the main door of the switch is a smaller door giving access to the fuse compartment. This fuse compartment door is interlocked with the operating handle in such a way that it will not open until the switch is thrown to the off position. In this position, even with the door open no live parts are accessible and as long as the door remains open the switch cannot be thrown on. The outer door covering the entire switch enclosure is designed for padlocking so that it can be opened only by an authorized person. This door can be opened for inspection and testing without interrupting the service.

The design of a new "make and brake" mechanism, entirely contained in the operating handle outside of the cabinet, does away with the possibility of failure of the switch box to function properly, which would produce dangerous short circuit hazards. This design removes

the danger of loose parts coming in contact with current carrying parts of the switch and leaves more space.

An arc quencher of simple design has been developed that serves to extinguish the arc quickly and efficiently when the circuit is opened. It consists of metal laminations, separated by layers of insulation and air space. As the blade traverses the quencher, the arc is broken into a series of sparks that are cooled by the metal plates and by the air currents between them. As the blade passes through the quencher, the arc is dissipated and cooled to such an extent that the current drops to zero and the circuit is interrupted without danger or damage. The arc quencher is capable of breaking circuits carrying from 50 per cent more current in the larger sizes to 300 per cent more in the smaller sizes than the rated amperes of the switch, even at 500 volts.



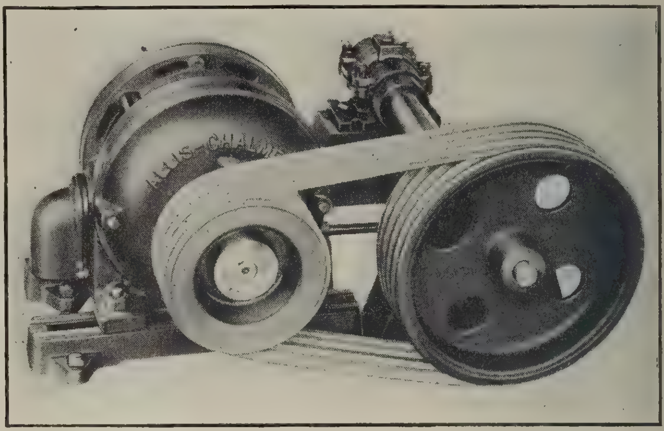
Westinghouse Safety Switch Provided with a Double Door to Prevent the Operator Coming in Contact with Live Parts When Changing Fuses

A Flexible Short Center Drive

The Allis-Chalmers Mfg. Co., Milwaukee, Wis., has recently perfected a new type of short center, flexible drive, known as the Texrope Drive.

The drive consists of two grooved sheaves and a number of specially constructed endless "V" belts. The sheaves are set just far enough apart so that the belts fit the grooves without either tension or slack.

Since the Texrope belts just fit the sheaves, there is no appreciable slack or lost motion in the drive. Because of the "V" construction, the belts cannot slip, as the harder the pull the more firmly the belts grip the grooves. As the belts are elastic they act as cushions between the driving and driven machines and do not transmit vibrations. Bearing pressures are low, since no initial belt tension is employed. The drive occupies very little space. It is silent, clean, and according to the manufacturer is unaffected by moisture or dirt. Since there is no appreciable slip, the speed ratios are fixed and exact.



An Exhibition Model of the Allis Texrope Drive

Texrope Drives from ½ to 250 hp., with ratios up to 7 to 1 and belt speeds from 800 to 6,000 feet have already been placed in service.

Lighting Fixture With Flexible Conduit Stem

The Central Electric Company, Chicago, Ill, has recently added to its line of lighting fixtures, a new number, consisting of a pendant type fixture with the chain replaced by a flexible steel conduit, as shown in the illustration. It is known as the Flex Stem Attalite.

The Flex Stem Attalite

This gives the appearance of a solid stem fixture with the flexibility which is so desirable for any unit using a large glass globe. The wire is entirely enclosed and the general effect is neat and trim. The flexible conduit is secured at top and bottom by a special patented process, eliminating the use of set screws.

General News Section

The Chicago Fuse Manufacturing Company of Chicago, announces the removal of its Detroit office from the Transportation Building to 429 Wayne street.

The Electric Service Supplies Company, Philadelphia, Pa., has removed its Chicago office from the Monanock building to the Illinois Merchants Bank building, 230 S. Clark street.

Gerard Swope, president of the General Electric Company, has announced that orders received by the company for the three months ending September 30 amounted to $73,561,483, compared with $58,389,832 for the same quarter in 1924, an increase of 26 per cent.

For the nine months of the present year, orders total $223,876,711, compared with $203,097,719 for the first nine months of 1924, an increase of 10 per cent.

As a step in the modernification of its electric railway equipment, the Havana Electric Company of Cuba is discarding the motors it has used for upwards of 25 years, and is installing motors of modern type. The company is now obtaining through the General Electric Company of Cuba its second hundred GE-264 B motors this year. The motors, rated at 25 horsepower and 600 volts direct current, are being installed by the company in its own shops.

Motor trucks are now used by 51 steam railroads for hauling freight on public highways. This statement is made by the National Automobile Chamber of Commerce, following an inquiry which was answered by about 200 railroads. This total compares with 33 such trucks a year ago. Twenty steam railroads now use 219 motor buses, and 190 steam and electric railroads use about 500 rail motor (gasoline) passenger cars. Many other roads are contemplating improvements of the kind here noted.

The Robert June Engineering Management Organization of Detroit has acquired control of the Electric Flow Meter Co. at Kansas City, Mo., formerly the Hyperbo-Electric Flow Meter Co. of Chicago, and will henceforth operate the business under its own management with executive offices at 8835 Linwood avenue, Detroit, Michigan. Robert June becomes president of the company, J. M. Naiman, formerly general manager becomes vice-president, consulting and chief engineer with Major W. W. Burden of the Robert June organization as treasurer.

Four General Electric men were killed and two were injured in the train wreck which occurred on the Pennsylvania Railroad near Plainsboro, N. J., November 12. The dead include R. D. Reed, a member of the General Electric industrial department and in charge of the sale of electric arc welding equipment; Mark A. Atuesta and Arthur W. Gross, members of the manufacturing department, and John C. Horstman of the manager's staff at the Schenectady plant. Among the injured were D. H. Deyoe of the Industrial Engineering department of the company and Thomas Wry, of the Lynn River works. All the men had met in Baltimore in connection with the inter-works welding committee of the General Electric Company and were en route to the Bloomfield plant when the accident occurred.

"Thirty-one Million Railroad Crossings Without an Accident," is the title of an advertisement which the Standard Oil Company of Indiana, Chicago, is publishing in newspapers in the West. During 1924 the vehicles operated by the Standard Oil Company crossed railroad tracks 31,000,000 times without an accident. This is an average of 85,000 crossings a day. This record is attributed to the effort on the part of the management to impress all employees with the need and desirability of careful driving. The company pointed out the dangers of careless driving and furnished placards reading: "This car stops at all railroad crossings." Each driver was asked to pledge himself to co-operate and to evidence his good intentions by displaying the placard on the rear of his machine.

The Pennsylvania announces that work is to be begun at once on the laying of wires under ground for all of the telephone, telegraph and signal circuits between Philadelphia, Pa., and Wilmington, Del., 26 miles. This work is preliminary to the electrification of this section of the road (four track); and the new construction will take the place of all of the present pole lines. New steel poles will then be put up for the propulsion current. The underground construction which is to be on the extreme outer edge of the right-of-way will consist of six creosoted wooden ducts in which will be laid lead-incased cables. It is planned to have this work done by Spring. In connection with this announcement it is stated that the Pennsylvania has practically completed the placing of all of its wires underground between New York and Philadelphia, 90 miles.

June Mechanical Convention

After a joint meeting of the General Committee of Division V—Mechanical, American Railway Association, and the executive committee of the Railway Supply Manufacturers' Association, held in Philadelphia, October 13, it was decided to hold the annual convention of Division V and the R. S. M. A. exhibit on Young's Million Dollar Pier at Atlantic City, N. J., June 9-16, inclusive. In all probability Division VI—Purchases and Stores, A. R. A., will hold its annual convention at Atlantic City at the same time.

Further Electrification in Italy Planned

The Italian Minister of Railways and Communications has authorized the immediate electrification of the line from Genoa to Ovada, according to Modern Transport (London). Authority has already been granted for the

electrification of the Ovada-Alessandria line. It is likewise proposed to electrify the track between Ovada and Asti, thus carrying into effect the first part of the project recommended by the Genoese committee appointed to inquire into the whole question of the railway electrification of this area.

Power Show to Be Held at New York

The Fourth National Exposition of Power and Mechanical Engineering will be held in the Grand Central Palace, New York, from November 30 through to December 5, 1925. The Power show, as this exhibition is styled, is an important clearing house of information for the executives and engineers of all industries. At the coming show a series of exhibits of heating and ventilating machinery will form an important addition to the lines usually represented.

The list of exhibitors to whom space has been assigned indicates the thoroughness with which the field of power generation and use will be covered.

As usual, the annual meetings of The American Society of Mechanical Engineers and The American Society of Refrigerating Engineers will be held during the week of the show and their programs have been planned to allow opportunity for a thorough inspection of the exhibits.

Railroad Electrification Being Extended Abroad

The general extension of electrified railroads throughout the world is indicated by shipments of equipment which is being made from this country to Japan, Cuba, Brazil, Mexico and South Africa by the International General Electric Company. All of the equipment is for the extension of present facilities, except in the case of the Natal division of the South African Railways, newly electrified for a distance of 171 miles.

The Paulista Railway is extending its electrification in the section from Tatu to Rio Claro, a distance of 25 miles. The International General Electric Company is furnishing four 62-ton, 3,000 switching locomotives, the equipment for a 3,000-volt sub-station, and the necessary line equipment.

Four locomotives weighing 66 tons each are being shipped to Japan by the same company. These engines are for the Japanese government.

Three 60-ton engines are to be sent by rail to Florida and from there to Cuba by ferry. The units, for the Hershey Cuban Railway, duplicate those supplied several years ago.

The Mexican Railway, following its initial electrification over the Maltrate incline, is extending the electrified portion 17 miles eastward.

No Employees Killed in Two Years

The Northwestern Pacific, operating 500 miles of road with 2,500 employees, has not had an employee killed in an accident while on duty for over two years, the last employee fatality having occurred on September 24, 1923. The record of employees injured in 1924 showed an improvement of 32 per cent over 1923; and a 17 per cent reduction as compared with the preceding five years.

William S. Wollner, general safety agent, reports that the road has not had a passenger killed in a train accident in the seven years that it has maintained a safety organization, although during this period eight passengers lost their lives in "train service" accidents, while trying to board or leave moving trains.

Personals

Ernest Wanamaker, electrical engineer of the Chicago, Rock Island & Pacific Railway was elected president of the Association of Railway Electrical Engineers at the recent annual convention of the Association in Chicago. Mr. Wanamaker was born in Missouri and as a boy spent his time in bothering railroad men and contractors in an endeavor to learn the practical side of engineering. When old enough, he entered the employ of various operating and contracting concerns and finally, at the age of 18, secured a position with the Western Telephone & Telegraph Co. After about two years in this work he was appointed line foreman for the Colorado Power Company at Canyon City and Cripple Creek at the time when Cripple Creek was the largest gold mining camp in the world. He then served about three years at sea as a marine engineer, and before quitting the sea was awarded a second engineer's certificate.

Ernest Wanamaker

At the age of about 24, he entered the employ of the U. S. Reclamation Service in connection with the work of driving the Gunnison tunnel in Colorado and was soon appointed superintendent of power and machinery. This tunnel is six miles long and diverts the Gunnison River from the Black Canyon of the Gunnison into the fertile but previously arid valley of the Uncompahgre river. Pioneer methods were employed in driving this tunnel, both on account of its extreme length and also on account of the fact that it was the first big tunnel in the United States in which electric power was used for everything except the air drills.

After three years' work on the Gunnison tunnel, in which he had charge of all mechanical and electrical equipment, Mr. Wanamaker entered the employ of the Arnold Company of Chicago. With this company he spent several years as engineer and superintendent of construction, engaged in the construction of railroad repair shops, power plants, electric railways, hydroelectric power plants, etc. During this time the new Frisco shops at Springfield, Mo., were built and here he was superintendent of temporary construction and had charge of the installation of all electrical and mechanical machinery. A record was made on the installation of the electrical and mechanical equipment on this job, all machinery and electric wiring being installed within a period of 60 days. For the greater part of the time there were over 120 electricians employed on the work.

In 1913 Mr. Wanamaker became chief engineer of the

Rock Island Lines at the main shops of the company at Silvis, Ill., being appointed electrical engineer for the Rock Island R. R. December 1, 1914, and now has charge of all electric lighting and power equipment in railroad shops, car lighting, train control, electric welding, etc.

During the war Mr. Wanamaker became deeply interested in the subject of electric welding and his subsequent experiments in this field have resulted in his becoming recognized as an authority on welding, particularly in its application to construction and maintenance in railroad work. Besides being a contributor to the *Railway Electrical Engineer* and other magazines, Mr. Wanamaker is the joint author of a book on electric arc welding.

E. A. Lundy, president of the E. A. Lundy Company of Pittsburgh, Pa., was elected president of the Railway Electrical Supply Manufacturers Association at a meeting held in Chicago, October 29. Mr. Lundy is a graduate of Pratt Institute, Brooklyn, N. Y., electrical engineering department. His first railroad experience was with the Atlantic Coast Line in the electrical department. After a year's service a transfer was secured to the signal department, where he was engaged from March, 1913, to September, 1916, in various capacities on construction and maintenance work. From September, 1916, to June, 1918, he was connected with the signal department of the Long Island Railroad. Upon leaving the Long Island, Mr. Lundy entered the services of the Union Switch & Signal Company and remained there until January, 1920, at which time he resigned to accept a position with the Simmons-Boardman Publishing Company. With this company he served in various capacities which included the business managership of the *Railway Electrical Engineer* and Railway Signaling which position he held at the time of his resignation to enter the railway supply field.

E. A. Lundy

Theo. Schou, chief engineer of the Ideal Electric & Manufacturing Company of Mansfield, Ohio, has just returned from a four months' visit to Europe.

A. H. Darker, chief electrical engineer of Messrs J. Stone & Co., Ltd., left England by the P. and O. steamer "Narkunda" on October 23rd on a business tour through Ceylon, India, Burma, Australia, New Zealand and America.

Sir Thomas O. Callender, managing director of Callender Cable Construction Company, Ltd., London, England, has arrived in this country on a visit after an absence of some years. In addition to inspecting some of the most recent of the power plants in this country, including those established by his friend, Samuel Insull of Chicago, he will inspect the recently established cable plant of the Okonite-Callender Cable Company, Inc., Paterson, N. J., in which his company is jointly interested with The Okonite Company. A photograph of Sir Thomas and a sketch of his career was published in the *Railway Electrical Engineer* for May, 1925.

L. F. Miller, who recently became associated with the Industrial Controller Company, Milwaukee, Wis., will have charge of their railroad department, with headquarters in Chicago, in conjunction with their Chicago office. Mr. Miller was born in Toledo, Ohio, but moved to Huntington, W. Va., where he attended high school. After graduating from high school, he entered the shops of Chesapeake & Ohio as an electrical apprentice. Later, he worked in the motor and testing department of the Westinghouse Electric & Manufacturing Co. at East Pittsburgh, Pa. He has had a wide range of electrical experience in construction, installation and maintenance, having been in charge of construction work for a large electrical contracting company. For a time he was with the American Car & Foundry Company at Detroit, Mich. Returning to the Chesapeake & Ohio in 1919 he was road foreman of electricians until November 1 of this year, when he resigned to accept his present position with the Industrial Controller Company.

L. F. Miller

Hoyt Catlin, advertising manager of the Bryant Electric Company, Bridgeport, Connecticut, has resigned from that organization to enter the advertising agency business as associate and production manager of the E. T. T. Williams and Associates, New York City.

For ten years Mr. Catlin was engaged in the public utility field erecting and operating electric, gas and ice plants. Coupled with these activities he spent five years in the South developing new wood distillation processes and performing research work upon new fibres for paper making. For two years he was employed by the Pacific Power and Light Company in Washington, part of the time as electric range specialist.

Hoyt Catlin

In 1917 he was engaged by Landers Frary and Clark of New Britain, Connecticut, to develop electric ranges. He became connected with the Bryant organization early in 1919 as sales engineer, and since February, 1921, has been advertising manager of that company, all of whose advertising he has written and directed.

Mr. Catlin has been president of the Advertising Club of Bridgeport for the past three years. He is a director of the Employees Tuberculosis Relief Association of Bridgeport, a director of the Associated Advertising Clubs of New England and second vice-president of the Technical Publicity Association of New York.

A. S. Knox, railway department, sales and service Edison Storage Battery Company, has been transferred from Chicago, Ill., to Denver, Colo. Mr. Knox's work will be similar to that which he did when connected with the Chicago office and covers industrial trucks, signals and car lighting. His territory will include the Union Pacific System and all other roads west of the Mississippi River as far as Salt Lake City.

Mark C. Pope, who has been connected with the Washington, D. C., branch of the Electric Storage Battery Company for the past five years, has been promoted to manager of the Atlanta branch. Prior to his service with the Electric Storage Battery Company Mr. Pope had served with the General Electric Company at Schenectady, N. Y., and later with the International General Electric Company. Roland Whitehurst, who has been manager of the Washington branch for a number of years, has taken over the duties heretofore handled by Mr. Pope; A. H. Adkins will assist Mr. Whitehurst in this work.

Obituary

Allen A. Tirrill, 52 years old, an inventor and consulting engineer of the Westinghouse Electric and Manufacturing Company, died recently. Mr. Tirrill was the inventor of a voltage regulator bearing his name.

For many years he was associated with the General Electric Company, Schenectady, N. Y., and in 1910 became an engineer at the Westinghouse Company. He left the company in 1916, but since that time had been one of its consulting engineers.

He built the first dynamo and installed the first electric lights at Stewartstown, N. H., and constructed virtually all of the water power plants in Northern New Hampshire. In 1897 he put in the first voltage regulators in Lakeport and Concord, N. H. Mr. Tirrell sold his patents to the General Electric Company in 1902, and in 1910 the company sent him on a tour of Europe to demonstrate the practicability of the regulator. In 1914 he was awarded the John Scott legacy medal for his meritorious inventions, together with a diploma. He was a member of the American Institute of Electrical Engineers.

George Y. Allen, radio engineer for the Westinghouse company was among those killed in the train wreck on the Pennsylvania Railroad near Plainsboro, N. J., Nov. 12.

Trade Publications

The International Signal Company, New York, in a recently issued 30-page bulletin entitled "Webb Automatic Train Control" illustrates and describes the Webb train control equipment.

Erie Malleable Iron Company, Erie, Pa., in a little publication called the "Story of the Kondu Box," tells by text and pictures of the development of a new principle in the installation of conduit for wiring.

The General Electric Company, Schenectady, in its October, 1925, bulletin illustrates and describes a portable timing device. The device finds numerous applications for timing various graphic instruments, meters, etc.

Flood Lighting Projectors is the name of bulletin No. 216 recently published by the Electric Service Supplies Company, Philadelphia. The book contains 72 pages and illustrates the various types of Golden Glow flood lighting projectors.

Chicago Steel & Wire Company, Chicago, Ill., has recently issued a small bulletin of 28-pages entitled "Properties of Steel Filler Rods" for gas and electric welding. The book is practically a treatise on the properties for iron and steel filler rods for welding.

Victor Balata & Textile Belting Company, New York. A four page illustrated folder shows its new type of car lighting belting which is reinforced with steel wired staples on the edges. The reinforcement makes a stiff belt laterally but gives ample flexibility longitudinally.

O. C. White Company, Worcester, Mass., in its catalogue No. 26 illustrates a large number of adjustable electric light fixtures for many different applications. The book contains 20 pages, and practically every place where an adjustable fixture can be used to advantage, is shown.

Ball and Roller Bearing Reliance Motors is the title of bulletin No. 4000, recently issued by the Reliance Electric & Manufacturing Company, Cleveland, Ohio. The bulletin contains illustrations and descriptive matter concerning both direct and alternating current motors manufactured by the company.

Bridgeport Brass Company, Bridgeport, Conn., has just published a 20-page illustrated booket entitled "A Historical Sketch of Bridgeport Brass Company." Besides being an outline of the development of the company from 1865 to the present, the booklet contains many interesting sidelights touching upon inventions of the past sixty years.

Electrical Supplies.—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is distributing its new 1925-27 catalogue of electrical supplies. The publication contains 1,200 pages and is profusely illustrated with 4,500 engravings. All new apparatus designed and manufactured in the past two years, as well as all the previously established types are listed. A very complete subject index in the front of the book is printed on blue paper so that it can be quickly located, and a style number index for checking invoices is located in the back of the book. A classified index under such classifications as central stations, electric railways, industrial plants, mines, etc., gives a complete list of apparatus applicable to each of these groups of industries, and the thumb index enables the user to locate any section of the catalogue with the least inconvenience.

Railway Electrical Engineer

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Better Office Lighting

The importance of good illumination has been emphasized many times in the columns of the *Railway Electrical Engineer* but it is doubtful if it would be possible to advocate this cause to too great an extent. There are many places where daylight is absolutely lacking at all times, and it is only when adequate lighting units are provided in such locations that efficient service can be rendered by those who of necessity must work in such places.

In large offices, where much clerical work is carried on, the importance of good illumination should never be overlooked. If the light furnished is not suitable for the work to be performed, the fact is quickly reflected in the large number of errors which result, to say nothing of the injurious effect on the eyesight of the employees.

In an article on page 385 of this issue, some of the results of office lighting experiments are given and it requires but a brief glance at the illustrations to note the greatly improved conditions when the correct lighting units have been installed.

There are many railway offices where some of the suggestions offered in this article may be followed to the betterment of the service and the health of the employees as well.

Importance of Grounding

The question of grounding electrical circuits and conduits is one which deserves much more thought and care than is usually given to it. Electrical circuits are grounded for two important reasons, first, as a method of reducing fire hazard, second, as a means of preventing dangerous electrical shocks to persons accidentally coming into contact with apparently low voltage circuits.

The practice is of value only in so far as it accomplishes these results, and the results are achieved only when the ground connections are maintained in first class condition. There has been in the past and still is a tendency to make ground connections in a rather flimsy manner with light weight materials of insufficient size and strength. It is quite true that many grounds when first made are practically 100 per cent perfect, but unless the proper kind of materials have been used and full consideration has been given to the installation of the ground system, it is more than probable that the value of the ground will depreciate rapidly to a point where it becomes an actual menace rather than a safeguard.

There should be no occasion for such a condition to arise, and it would not arise if the proper degree of care were employed in preparing correct specifications for ground connections and following them out to the letter in the installation work. Electrical engineers should give this question much more attention; it is quite in keeping with the constantly increasing demand for better and more reliable electrical equipment as well as for uninterrupted service.

Building-Up Battered Rail Joints

The practice of building-up battered rail joints by the gas welding process is meeting with wide favor by the railroads. The outstanding advantage of the practice is that it obviates the necessity of taking up battered rails, cropping the ends and replacing them. Much labor is saved in this way and traffic is not interfered with. In addition to reclaiming the rail, the building-up process reduces wear on the ties, spikes, angle bars and bolts and less labor is required to maintain a smooth riding track. When trains pass over a battered joint they cause an excess amount of vibration which works the ballast from under the ties. This causes a low joint which cannot be kept tamped up.

It is possible that this class of work can be done equally well by the electric arc process, but up to the present time very little progress has been made in this direction. The Southern Pacific is one of the few roads which has made a serious effort to determine the possibilities of the process. About three years ago this railroad installed a gas engine generator outfit which has worked constantly in Los Angeles building-up battered joints and manganese castings, such as frogs, crossings and castings. An additional machine was purchased recently which is operating on the East Bay electric division, building-up battered joints. Two years ago, 100 joints were built-up by this process on high speed main line track of the Sacramento division as an experiment and the results have led the company to venture further into this method of welding.

Obviously, if the electric arc method proves to be practicable, it will represent an additional saving, as the cost of electric current, even though developed by a small gasoline engine, is less than the cost of the gas delivered to the points along the road where it is needed. If the process is to come into its own, however, it will probably be necessary for the electrical department on the railroads to assist in its development. The electric welding manufacturer cannot afford to render engineering service as

the gas welding manufacturer does because the former derives no revenue from the sale of electric energy while the latter has a good market for gas.

Possible Electrical Economies

There is probably no other agent so full of possibilities for effecting economies as electrical energy. This is particularly true where the matter involves the application of motors. Countless thousands of fractional horsepower motors are in use today performing innumerable duties which were either previously done much more expensively by hand, or not done at all. Going a step further in the field of motors under ten horsepower, there are many places in the railroad operating program where these machines can be used to replace small steam driven units which are for the most part exceedingly inefficient. A single instance of the advantage of electrical motors in the roundhouse may be cited. In the past, and to a very large extent at the present, steam pressure in locomotives is built up by the use of a forced draft derived from compressed air which in many cases is obtained from a steam driven compressor. This practice is expensive, but of necessity has been used until recently. During the past year, an electrical driven fan has been developed which can be placed immediately over the stack of the locomotive to produce the necessary draft. The cost of blowing a locomotive in this way is very much less than by the old method. In some cases where steam boilers have been maintained for the principal purpose of supplying power for roundhouse use, the electrical motor has displaced the boiler entirely. In other instances where it is necessary to maintain some steam boilers for heating purposes, partial replacements have been made.

All savings resulting from the use of electrical energy must naturally take into consideration the cost of power and reliability of service, but as both of these factors are becoming more and more favorable to the consumer of electrical power, there is a constantly growing incentive for a greater increase in the use of electric motors, and it is for the electrical engineers to ferret out the places where electrical operation will be of advantage, and present the facts to the management in such a way that the resulting economies may be realized.

How Railroads Can Use Radio

Suggestions as to how the railroads can use radio advantageously have been left as a heritage by George Young Allen, whose death is announced elsewhere in this issue. Summed up in brief they are as follows: 1. Space radio communication for emergency purposes. 2. Communication over existing telegraph and power wires to increase the number of communicating channels. 3. Communication between front and rear ends of long freight trains. 4. Portable apparatus suitable for attaching to hand cars or gasoline driven cars to cover moderate distances in an emergency. 5. Short range portable sets that can be carried by track walkers.

Some readers may criticize certain of the suggestions as impracticable, but most of them have already been tried out and there are other valuable applications of radio to railroads which have not been included. A few railroads have gone to the expense of installing equipment to substitute for telegraph and telephone lines in an emergency when the lines are made inoperative by storms, and when one such emergency has arisen the expense of the radio equipment has been justified.

Phantom telegraph and telephone circuits have greatly increased the amount of service which can be obtained from a small number of wire lines, but if wired wireless radio communication is used to supplement wire service the amount of service can be multiplied many times.

Communication between the front and rear ends of trains has been worked out experimentally and if this is developed it may easily be used for communication between trains or between a dispatcher and a train.

The suggestions do not include any mention of the use of radio on passenger trains for the entertainment of passengers. Comparatively little progress has been made in this direction in the United States, but no transcontinental train on the Canadian National is ever out of touch with a Canadian National broadcast station. It is felt on this road that the radio has demonstrated its usefulness and it has made many friends for the railroad among the traveling public.

A unique application of radio has been developed by one road in this country on which radio sets have been installed in a yardmaster's office and on pusher engines so that the yardmaster was able to direct the movements of the pusher engine. The experimental equipment used has not been retained in service but its usefulness has been demonstrated.

The advance of radio development during the past five years has been so rapid that it is not surprising that practicable applications of the kinds suggested have not followed at as rapid a pace. Now, however, radio equipment is approaching a state of relative standardization and it remains to the more progressive roads to take advantage of the many inherent possibilities of radio communication.

New Books

Rewinding Small Motors. By Daniel H. Braymer and A. C. Roe. N. Y., McGraw-Hill Book Co., 1925. 247 pp., illus., diagrs., charts, 9 x 6 in., cloth $2.50.

The motors to which this book refers include all those in common use for portable drills, grinders, automobile starters, sewing machines, desk fans, vacuum cleaners, washing machines and similar shop and dwelling equipment. The authors have attempted to compile details about the procedure in winding these motors which will enable an experienced winder to rewind or change them without difficulty.

Coils and Magnet Wire. By Charles R. Underhill, N. Y., McGraw-Hill Book Co., 1925. 494 pp., illus., diagrs., tables, 9x6 in., cloth. $4.00.

Although coils are found in every electromagnetic device, specific detailed information on the preparation of magnet wire and on the manufacture and insulation of coils has been difficult to find. This book goes very fully into these questions and other practical matters involved in the construction of coils and should be a welcome addition to the literature on the subject.

Car Lighting Practice on the Southern Pacific

An Unusually Systematic Procedure is Applied to 800 Cars on Nearly 9000 Miles of Pacific System Lines

CAR lighting has been brought to a high estate on the Southern Pacific by the well defined and consistent effort of the electrical men backed by the effective co-operation of the entire mechanical department. The very natural result of this rather unusual situation is high quality service and low operating and maintenance costs.

The general train lighting shop for the system is located at Oakland, Cal., and the Oakland Shop is headquarters for car lighting maintenance work on the western lines. Car lighting headquarters for eastern lines are located at Houston, Texas. All work such as changing car lighting systems from gas to electric is done at Sacramento, Los Angeles, San Francisco and El Paso Shops. For the sake of simplicity only the western lines are considered in this article. These include all of the Southern Pacific Lines west of El Paso, the El Paso & Southwestern and the Arizona Eastern Lines.

Fig. 1.—Outer End of Six-Wheel Truck Showing Standard Creco Brake Beam

Equipment

A total of 797 axle equipped cars are maintained on the western lines. These are listed in table 1.

In addition to the cars listed in Table 1, there is one train operating between Oakland, Cal., and Chicago, Ill., that is lighted by the head-end system. Four baggage cars, are equipped with turbine-generator sets for the lighting of this train. Eight different types of equipment are used in lighting the 797 cars listed in Table 1. These are divided as follows: Bliss, 6; Consolidated, 47; Gould, 49; Safety, 199; Newbold, 10; Moskowitz, 2; U.S.L., 475; Straight storage, 9.

The company still operates quite a number of gas lighted cars, but groups of these are being changed over to electric at the various shops each month and program in force provides for the removal of gas from all steel passenger cars and the application of axle light devices with the most modern lighting fixtures, fans, etc. Practically all of the axle equipment is body hung. Truck suspension is used only on a few diners on which space under car, due to so many equipment boxes, etc., did not permit mounting the generator on the car underframe.

All axle pulleys are mounted on the center of the axle. A pulley ratio of about 2 to 1 is used on all body hung machines. Axle pulleys are 17 in. or 19 in. in diameter and have a 14 in. face and a 2 in. flared flange.

TABLE 1

Cars Equipped with Axle Light

	Type of car	No.
S.P.	Wide window coaches	26
S.P.	Narrow window coaches, 60 ft	63
S.P.	Interurban Coaches	70
S.P.	Narrow window main line coaches, 72 ft	19
S.P.	Straight baggage cars	23
S.P.	Comination mail and baggage cars	35
S.P.	Club cars	33
S.P.	Mail cars	2
S.P.	Cafe observation cars	2
S.P.	Observation cars	4
S.P.	Observation cars—Open air	3
S.P.	Dining cars	98
S.P.	Business cars	25
S.P.	Chair cars	11
S.P.	Horse cars	6
S.P.	Cabinet lunch coaches	12
S.P.	Cabinet lunch chair cars	6
A.&E.	Coaches	9
A.&E.	Combination mail and express cars	5
A.&E.	Combination baggage and passenger cars	2
E.P.&S.W.	Dining cars	2
E.P.&S.W.	Chair cars	2
E.P.&S.W.	Coaches	11
E.P.&S.W.	Baggage cars	11
E.P.&S.W.	Club cars	3
E.P.&S.W.	Business cars	5
E.P.&S.W.	Mail cars	2
E.P.&S.W.	Combination mail and baggage cars	2
E.P.&S.W.	Cafe observation cars	2
E.P.&S.W.	Observation cars	4
	Standard Pullman cars	201
	Pullman Tourist cars	29
	Atlantic local Pullmans	63
		797

Fig. 2.—Brake Rigging on Six-Wheel Trucks Allows a Three-Inch Belt Clearance

Axles on which pulleys are mounted are taper turned and both solid and corrugated pulley bushings are used. Generator pulleys are 8, 9 or 10 in. in diameter and have an 8 in. face with a 2 in. flared flange.

On all six-wheel trucks, a standard Creco brake beam is used for the two wheels in the center and for the two on the outer end of the truck. This brake rigging

is shown in Fig. 1. The brake beam used on the inner pair of wheels is similar to that used on clasp brakes and is shown in Fig. 2. The belt runs over the drop-end of the truck frame and under the brake beam with a minimum clearance of three inches.

Four-wheel trucks with open ends, such as shown in Fig. 3, also have Creco brake beams. When the standard beam is used on the inside pair of wheels there is insufficient clearance between the brake beam truss and the axle pulley. To overcome this difficulty, a special shallow Creco brake beam with bottom connected lever is used

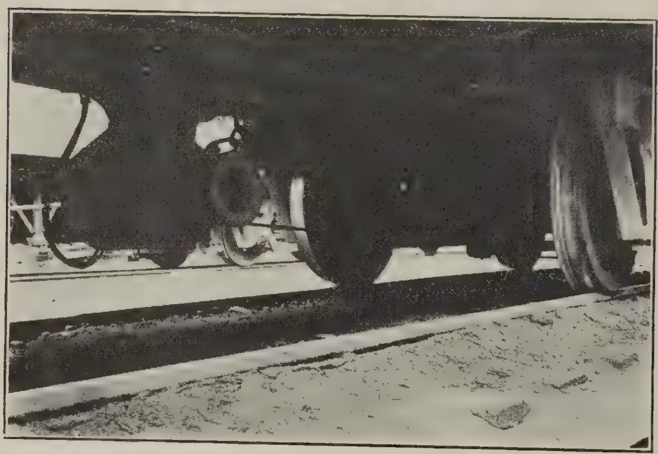


Fig. 3.—On Open-End, Four-Wheel Trucks a Special Shallow Truss Brake Beam is Used to Provide Clearance Between the Truss and the Axle Pulley

on the inner or generator end and the standard beam is used on the outer end.

On cars equipped with Commonwealth standard steel trucks with shallow end piece or sill, the truck has been altered to suit the car lighting belt requirements. The inner end piece is cut off and a riveted deep drop end applied as shown in Fig. 4. The brake beam is offset down so that the belt runs over the top of the truck frame and between the truck frame and the brake

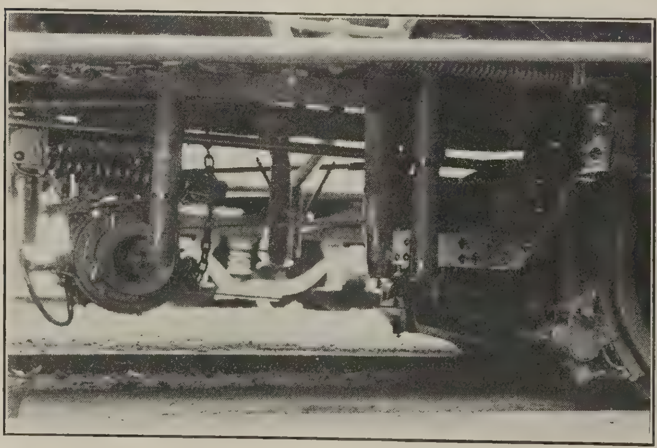


Fig. 4.—A Commonwealth Standard Steel Truck Modified to Suit Axle Light Requirements

beam with a minimum of 3 in. belt clearance. The same general procedure is followed for wood trucks. The outer end of a wood truck is shown in Fig. 5, and the inner end with modifications for belt clearance is shown in Fig. 6.

The under frame equipment shown in Fig. 4 is on a diner and the pipes which project down in several places are extensions of drain pipes put on to prevent water dripping on the belt. These have been found to be a great help in the winter time.

Belts

Four-inch, four-ply belts are used on all equipments and are applied with Crescent fasteners. This type of

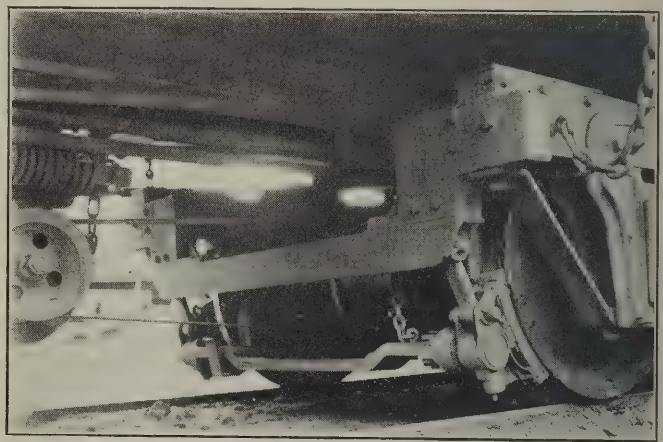


Fig. 5.—Inner End of Wood Frame Truck Modified to Suit Car Lighting Requirements

belt was chosen in an effort to reduce belt costs to a minimum. It is felt that while a heavier, more expensive belt might give greater total mileage, yet many belts are lost, due to rough handling of cars or improperly applied fasteners and others are lost or spoiled by pulleys being out of line, etc. The cost of the 4-in., 4-ply belt is about 27 cents per foot, and accordingly the

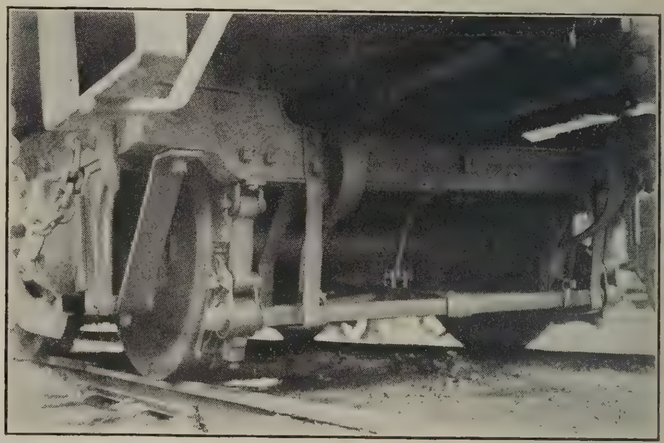


Fig. 6.—Outer End of Wood Frame Truck Showing Original Design of Truck End and Brake Rigging

cost of belts per thousand car miles—which is the real cost—is low.

The belting is purchased on specifications as follows:

Specifications for Rubber Belting for Axle Light Dynamos

General.—This specification covers Rubber Belting to be used for driving axle lighting generators, as described below, to be delivered in rolls of approximately 500 ft.

Manufacturer.—The belting shall consist of the following:

(a) Four plies of cotton reinforcement. The thickness of the finished belt must be normally 7/32 inch but a variation of 1/32 inch above or below this size will be allowed.

(b) Rubber friction compound.

(c) Friction surface cover.

(d) All belting shall be made in accordance with the best manufacturing practice, as smooth as possible, and free from all defects of material or workmanship.

Reinforcement.—The cotton duck shall be well, evenly and firmly woven from good cotton, as free from unsightly defects, dirt, knots and lumps and irregularities of twist as is consistent with the best manufacturing practice.

Rubber Friction.—The cotton reinforcement shall be well frictioned on both sides with a durable rubber compound of a grade that will meet the requirements of the friction test and at the same time produce a most flexible belt which will readily conform to the small pulleys incidental to the service.

Friction Surface Cover.—The outside ply of cotton reinforcement shall have no other covering of rubber than that produced by the regular process of frictioning the cotton duck. It shall present a uniform surface after vulcanization.

Fig. 7.—Wide Window Coach Equipped With Center Mounted Direct Lighting Fixtures and Fans Having Rotating Air Deflectors

Rubber Belting.—The seam in the outside ply of duck shall be filled with a rubber cord or beading of good quality, fastened down with a rubber strip about ½ inch wide.

Physical Properties and Tests.—(Elongation Test for Belt).—Test specimens 20 inches in length shall have transverse reference lines marked upon them 10 inches apart and at equal distance from the ends. Under a load of 100 lbs. per inch per ply, the belt shall stretch not less than 16/32 inch nor more than 29/32 inch immediately after the application of the test load.

Tests.—Tensile Test.—The elongation test shall be continued to the breaking point in order to obtain the tensile strength, which shall not be less than 300 lbs. per inch width per ply. Rate of separation of the jaws of the testing machine shall be approximately ½ inch per minute.

Friction Test.—The quality of friction must be such as to stand the following test: A sample of the belt will be wrapped and fastened at ends to a wooden mandril 10 inches in diameter and approximately the width of the belt; mandril to be pivoted at supports so as to turn freely about center. A strip of the canvas ply will be detached at one end to which will be attached a 20-lb. weight. The rate of unwinding must not exceed 4 inches in 10 minutes, on basis of strip one inch wide.

Beading Test.—A four-inch transverse section of frictioned belting shall be taken and beginning on the seamless side of the plies shall be removed until only three remain intact. A line shall be drawn down the middle of the beading and then on each side of this line, and ⅝ inch distant therefrom, two parallel lines shall be scribed. The section shall be inserted in a vise so that the jaws grip the sample exactly joining the two outer lines. The vise shall be tightened until the inner surfaces of the doubled samples just touch at the top of the vise and shall be held for 10 minutes. Under this test the beading shall not crack or loosen in the seam.

Marking.—(a) Badge plates shall be placed on all belting over 4 inches in width. These plates shall be of rubber vulcanized fast to the cover and shall be placed not more than 10 ft. apart on the belting. Each badge plate shall bear the manufacturer's name, or trade mark, date of manufacture and a serial number for each 500 ft. or fraction thereof of any one width, also each roll of belting must have applied on the proper side of the belting a badge reading "Run opposite side to pulley" or a thin metal strip reading "Run this side to pulley."

(b) The marking as specified in Paragraph (a) shall be legibly stencilled on all belting 4 inches in width and under.

(c) The serial number for all belting shall begin with "one" at the first of each calendar year and continue consecutively, irrespective of the width of the belting furnished.

(d) The Manufacturer's name, the order and requisition numbers, serial number, weight and number of feet in each roll, shall be legibly stencilled on the wrapper of each roll.

Sampling.—One sample, the full width of the belt, shall be taken from each lot of 500 ft. or less.

Remarks.—The Company reserves the right to make any further tests of this rubber belt to insure that the material shall meet the requirements and intent of this specification.

All rejected material will be returned to the manufacturer, who shall pay the freight charges in both directions. All specifications for rubber belting previously issued are hereby cancelled.

In connection with the subject of belts it is particularly interesting to note the results of a test made on the Southern Pacific in 1923. At this time 26 Pullman cars having truck mounted machines were fitted with new belts and 26 Pullman cars with body hung machines were also provided with new belts. These belts were allowed to run until they were lost or worn out and in the meantime a careful record was kept of the mileage made by each car. After all the test belts were gone an average of the mileage made by the belts on each type of equipment was made. The belts on the truck mounted machines ran an average of 23,060 miles, while the belts on the body hung equipment averaged 39,381 miles.

Fig. 8.—Observation Car Equipped With Semi-Indirect Center Fixtures, Bracket Side Lights and Paddle Fans

Car Fixtures

Coaches and chair cars are all equipped with No. 19032 safety center fixtures fitted with No. 18678 Ivanhoe-Regent heavy opal reflectors as shown in Fig. 7. Fifty watt, type C lamps are used in these units and there are eight fixtures in 60 ft. cars and ten fixtures in mail cars and in 72 ft. main line coaches. This provides a two-seat spacing. Sixty-foot coaches are fitted with three No. 19330 safety ceiling fans and 72 ft. coaches have four fans.

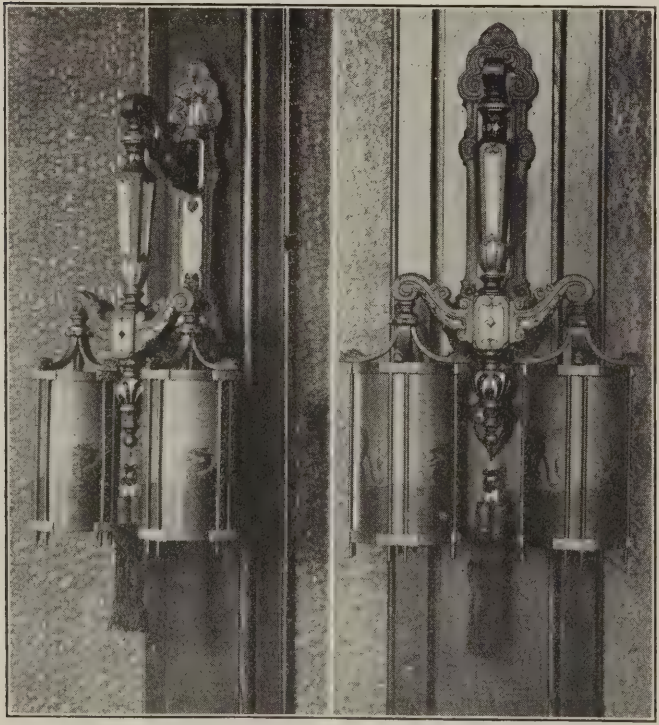
Recently converted cars to electric lighting, including observation cars, club cars and diners, have been equipped with No. 19127 safety semi-indirect fixtures with No. 50674 bowl and 75-watt lamps, as shown in Fig. 8. No. 19036 safety paddle fans are used in conjunction with the semi-indirect fixtures.

All regulator lockers have 4⅝-in. roof ventilators, Globe type, and a grill type ventilator near the bottom of the locker. The grill ventilator is placed ten inches above the floor of the car so that dirt from sweeping will not get into the locker.

Another article describing the car lighting maintenance methods used on the Southern Pacific will appear in an early issue of the *Railway Electrical Engineer.*

St. Paul Rebuilding Dining Cars

IN connection with the program of rebuilding its wooden dining cars of 30-seat capacity into 36-seat steel underframe diners, the Chicago, Milwaukee & St. Paul has installed some pilaster bracket lamps of novel Chinese design to harmonize with the ceiling lamps



Two Views of the Special Pilaster Bracket Lamps of Chinese Design

and fans. The ceiling decoration in these cars is a departure from present practice, as practically all moulding has been eliminated. The ceiling is covered on the underside with a heavy burlap, painted a light cream color, while the side finish is a plain Cuban mahogany.

The carpet has a black background with a floral pattern in Chinese red and the chairs are upholstered in black leather to match. A special feature of the cars is the side lights, which were designed particularly for this purpose, with parchment shades, hand painted. These fixtures are fitted with 25-watt lamps. It will be noted from the illustration that these pilaster bracket lamps are distinctively Chinese. They were furnished by the Safety

An Impression of Simplicity and Beauty Is Created by the Car Interior

Car Heating & Lighting Co. Special ornamentations are used on the ceiling lamps and the bases of the ceiling fans, matching those on the side wall fixtures.

To obtain a homelike appearance in the car, the buffet is built to a height common in dwellings. From the interior view it will be noted that in place of the ordinary decksash, shutters in the form of grills are inserted in the upper deck of the car.

The building season is gradually being lengthened as the result of a drive undertaken by the Construction Industries in co-operation with the Department of Commerce. This fact has been established through a survey made by the Division of Building and Housing of the Department at the direction of Secretary Hoover.

Munich-Wurzburg Express at Munich Central Station

View Showing Shortened Front End to Accommodate New Power Plant—The Car Hauls a Trailer in Regular Service

Gas Electric Drive Applied to McKeen Cars

Rock Island Equips Three With Electro-Motive Power Units at Horton Shop at a Cost of $70,000

By E. Wanamaker
Electrical Engineer, Chicago, Rock Island & Pacific, Chicago

WITH a background of 12 years' experience with two General Electric gas-electric cars, and a realization of the value of motorized equipment for light rail traffic, the Chicago, Rock Island & Pacific decided a few months ago to take another forward step in motorization by converting three old McKeen gasoline motor rail cars to the modern gas-electric type. These cars, converted at a cost of approximately $70,000, may now be operated as single units, or utilized in hauling some of the old, light-weight standard cars as trailers, thus making them available for light service on either branch or main lines. As a matter of fact, they have been placed on runs requiring the hauling of trailers.

Two of the converted cars, which weigh 40 tons and are 65 ft. long (originally 70 ft.), haul 28 ton, 50 ft. non-platform baggage car trailers. Their interiors are so re-arranged as to furnish accommodations for 84 passengers each, with all facilities for and complete separation of white and colored passengers. The third converted car is similar to the first two, except that it has no special provision for colored passengers and is operated with a 32-ton 53-ft., non-platform combination mail and baggage car trailer.

Converted Cars Give Satisfactory Service

Of the first two trains mentioned, the first is giving satisfactory service between Ft. Worth and Graham, Tex., making a round trip, including terminal mileage, of 194 miles daily, seven days a week. Of this distance 41 miles is between Ft. Worth and Bridgeport on the main line north from Ft. Worth, and 55 miles over a branch line from Bridgeport west to Graham. The train leaves the Texas & Pacific station in Ft. Worth at 5:00 p.m., arriving at Graham at 9:30 p.m., where it is left on the siding for the night. Leaving Graham the following morning at 7:15 in the morning it arrives at Ft. Worth at 11:35 a.m.

All stops are made both ways on the main line between Ft. Worth and Bridgeport; also on the branch line between Bridgeport and Graham, where it is the only passenger train service rendered.

The maximum grade encountered on this run is a short grade of 2.4 per cent with sharp curves climbing the hill from the Trinity river to the Texas & Pacific station. There are several long grades on the line between Ft. Worth and Graham, the heaviest being a 20,000-ft. 1.10-per cent hill, all of which are negotiated without trouble.

No trouble has been experienced in making the schedule. In fact it is easily possible to make up 15 to 20 minutes delayed time when operating conditions are good. It is believed that this leeway will enable the train to make needed time when suffering disadvantages from climatic conditions, undue delays, etc.

This two-car train furnishes ample facilities for serving the communities and territory in which it operates. The fact that the motor car is on the head end, driven by gas-electric power, assures the passengers of a ride free from dust as well as from cinders and smoke.

The second train is in service between Little Rock and Booneville, Ark. It operates as a local on the main line, making a round trip including terminal mileage of 246

miles daily, seven days a week. The train leaves Little Rock at 2:40 p.m., arriving at Booneville at 7:10 p.m., a distance of 119 miles. It returns, leaving Booneville at 7:00 a.m. and arriving at Little Rock at 11:30 a.m., making all stops.

Several grades are encountered and successfully negotiated on this run, the maximum being a one per cent grade 12,200 ft. long. The frequency of stops, location of stops as regards grades, and station work during the fruit season, make this schedule a fairly close one. However, the train has been able to make from 15 to 20 minutes better than running time, assuring ample reserve for ordinary weather and delay interferences.

toona, operating from Altoona to Eldon over a heavy branch line. The heaviest grade encountered is a 1.79 per cent hill, 3,100 ft. long. This equipment is furnishing good service to the patrons along the line, and the schedule allows sufficient reserve for adverse conditions which are encountered from time to time.

Ability of Train to Drift Important

On all of these runs the ability of the train to drift long distances is of much advantage and the enginemen are rapidly learning to take advantage of this ability, resulting in substantial savings in fuel, and smoother operation of the train, with promised reduction in engine maintenance.

Form M.P.
Gas-Electric

ROCK ISLAND LINES
Mechanical Department
MOTOR CAR INSTRUCTION AND RECORD

Car #________ Between ________ and ________ Month of ________

Enter Date, Condition, or Work Done, and Initials of Employe performing the work.

Grease Generator, pump shaft, center plates, twice every week.	Engine oil changed - every 1500 miles	Gears lubricated - every 1500 miles.	Valve tappets - inspect & adjust every week.	Carburetor screen & nozzles - check & clean every week.	Controller Contactors & Connections - check & clean every week.	Oil pipes check every week	All gauges & Instuments - check every week.	Traction Motor Leads Inspect every week.

	Generator Commutator brushes & holders - Check & clean every 2 wks.	Exciter Commutator Brushes & Holders - check & clean every 2 wks.	Traction Motors, Commutators, Brushes & Holders - Check & clean every 2 wks.	Fan Motor & Compressor, commutators, brushes & Holders - Check & clean every 2 wks.	Magnetos Distributors Spark Plugs - Check & Clean every 2 wks.	Sanders Whistle & Bell - Check & Clean every 2 wks.	Relay Contactors - Check & clean every 2 wks.

Water Pump packing - Inspect & Renew if necessary every 2 wks.	Radiator - Drain & wash out every 2 weeks.	All Wiring Connections - Check for tightness every month.	Oil strainers Remove & Clean every month.	Throttle & Air Starter- check, clean & Lubricate every month.	Air Compressor oiled every month.	Air compressor Oil changed every 2 months.	Inspect & Oil Traction Motor Gearings at least once every week. Allowable limit of wear 3/64"

Remarks:

This Monthly Record Card Gives a History of the Motor Car—Important Instructions Regarding Operation and Spare Parts Are Printed on the Back—It Is Forwarded to the Electrical Engineer's Office, Chicago, at the End of the Month

The equipment is ample to serve well the route along which it is operated.

The third train is in local service six days a week between Valley Junction, Des Moines and Eldon, Iowa, a run of approximately 108 miles. The every day run, including terminal mileage, is 220 miles a round trip. This train leaves Valley Junction at 6:00 p.m., arriving at Eldon, Iowa, at 11:10 p.m., making important passenger, mail and express connections at Oskaloosa, Ottumwa and Eldon. The run is heavy, 95 per cent of the capacity for mail express and baggage being utilized each trip and about 75 per cent of the passenger facilities.

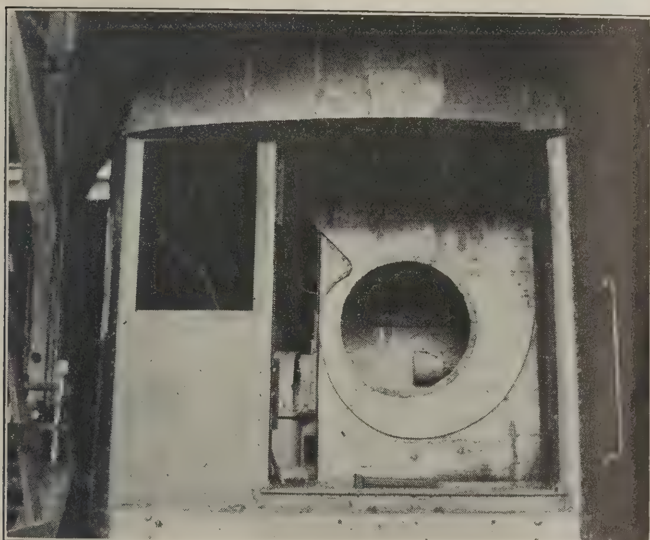
This train operates on the main line for a distance of 15 miles from Valley Junction, through Des Moines to Altoona, …

The total equipment weight of each of the first two trains is 68 tons; the total equipment weight of the third train is 72 tons. The third train carries a railroad post-office compartment in the trailer car. The other two trains handle only pouch mail. All three of the two-car trains stop, start and accelerate easily on the heaviest grades.

The trailer cars, as well as the motor cars, are heated by railway standard double coil Baker hot water heating systems. Also, the trailer cars are well lighted with 32-volt electric current obtained from the motor car 32-volt lighting system by means of Oliver plugs and receptacles. This form of lighting is of special advantage to the railway postal clerk working in the mail compartment of the combination mail and baggage car.

Conversion Work Started Last April

The actual work of converting the three cars started the latter part of April, 1925, at the Horton, Kan., shops of the Rock Island. Five feet was cut off the pointed front end of each car and the engine room stripped. The trucks and body bolster were removed and a new bolster of plates and structural shapes built in to form a suitable foundation for the engine and generator. Prior to this time, however, measurements and sketches were made of proposed changes in the body, and the necessary drawings for the bolster were on hand. A large percentage of the power equipment, supplied by the Electro-Motive Company, Cleveland, Ohio, was received about May 1 and a few days later a member of this company's engineering staff was on hand to assist in installing the equipment. Several sketches were made of the power plant and brake system layouts, and small drawings of tanks, brackets, cleats, etc., were made, while a small shop force proceeded with the work.



After Application of the Motor the Next Job Was to Install the Radiator and Fan Arrangement

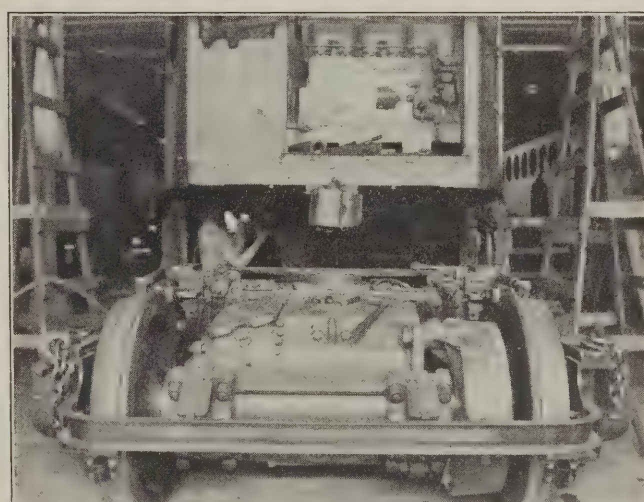
The work was confined largely to one car for the first three weeks, and then the men were shifted to the other two cars, a second force being started on other work on the first car. By June 10 the first car was finished, tested and started to Des Moines, Iowa, under its own power, going into service there June 15. This car pulled a 32-ton combination mail and baggage trailer from Horton to Des Moines, and from Purdy to Des Moines, a distance of 41 miles, making a schedule speed of 48 miles an hour, including three stops. The other two cars were completed and tested, leaving Horton as a two-car train June 24.

No trouble was encountered in rebuilding these cars. The connection of the bolster with side and center sills was very simple and easily constructed. By cutting off the sharp front end, sufficient room was made for installing the Electro-Motive radiator and fan arrangement, at the same time leaving ample space for the operator and a front clear vision window.

By employing the electrical type of transmission, it was not necessary to consider particularly the exact location of the engine and auxiliaries, as there were no clutches, change speed transmissions, drive shafts or universal joints to contend with. A few small changes were made in the car framing in the engine room and a large panel cut out on the left side of the car to be used to remove the engine in the event it is necessary. The panel is held in place with bolts. A small panel door is arranged on each side of the car in order to get at the gear case on the end of the engine and the exciter on the other side. It was necessary to change the location of one of the engine room windows and to make a special expansion tank for the engine cooling water that would fit the contour of the roof. The illustrations show that few changes were necessary for the conversion. The Electro-Motive standard power truck was used without any changes. Only a few changes were made in the foundation brake rigging to accommodate the A.M.L. Westinghouse equipment.

The power plant equipment consists of a Winton gasoline engine developing 175 hp. at 1,000 r.p.m., especially built for heavy duty railroad service, directly connected to a generator through a heavy flexible coupling. Electric power from the generator is transmitted to two 105-hp. standard traction driving motors geared one to each pair of wheels in the front truck.

The power truck is of the conventional design, consisting of side arch bars with equalizers and coil springs, swing bolsters mounted on full elliptic springs and M.C.B. journals. The old McKeen rear truck is retained in service. The operation of the gas-electric car is simple and quite similar to that of a locomotive, a throttle controlling the engine speed and obviously determining the amount of power being used. The controller serves to reverse the traction motors and to connect them either in series or parallel.



Close-Up View of Front Truck, Equipped with Two Electric Driving Motors, Before Applications to Car Body

Electrical Transmission Offers Important Advantages

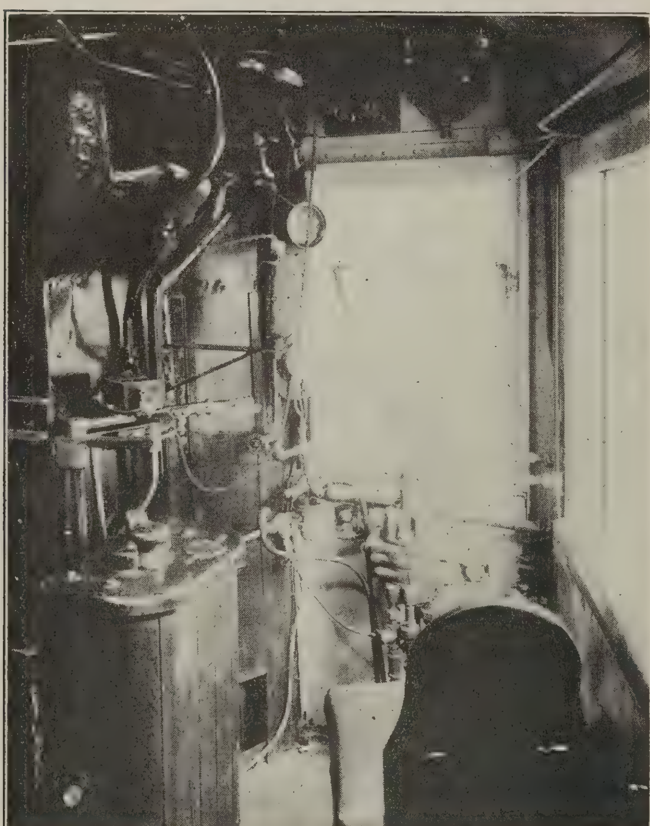
By employing electrical transmission of power to the driving wheels a quick and smooth acceleration is obtained, with a comparatively high starting effort. The transmission is flexible and self-adjusting for all different road conditions, leaving little need for the exercise of expert judgment and skill in the manipulation of the throttle and control handle. Consequently the average engineman is perfectly at home after riding and operating the car for a short time. However, enginemen and maintainers require careful instruction in order that the equipment may be properly operated and maintained, and they should be

given sufficient time to familiarize themselves with the equipment, becoming acquainted with the method of operation, the names of all the various parts, and the functions they perform.

The efficient distribution insofar as transportation economy is concerned, of motor cars over a large railroad system complicates or makes difficult of attainment a satisfactory service and maintenance performance, few steam railway employees having had an opportunity to become familiar with the operation and maintenance of motorized equipment. It has been necessary, therefore, to adopt a plan of education for all those having to do with the operation and maintenance of motor cars on the Rock Island, and the Horton shop was chosen as a shop for overhauling motorized equipment, being about centrally located and having sufficient space and facilities for the work. It is the intention to build up an organization at this point capable of thoroughly overhauling any motor equipment on the road.

Work of Conversion Completed in Seven Weeks

In line with this decision, the work of converting the three McKeen cars was carried out at Horton within the

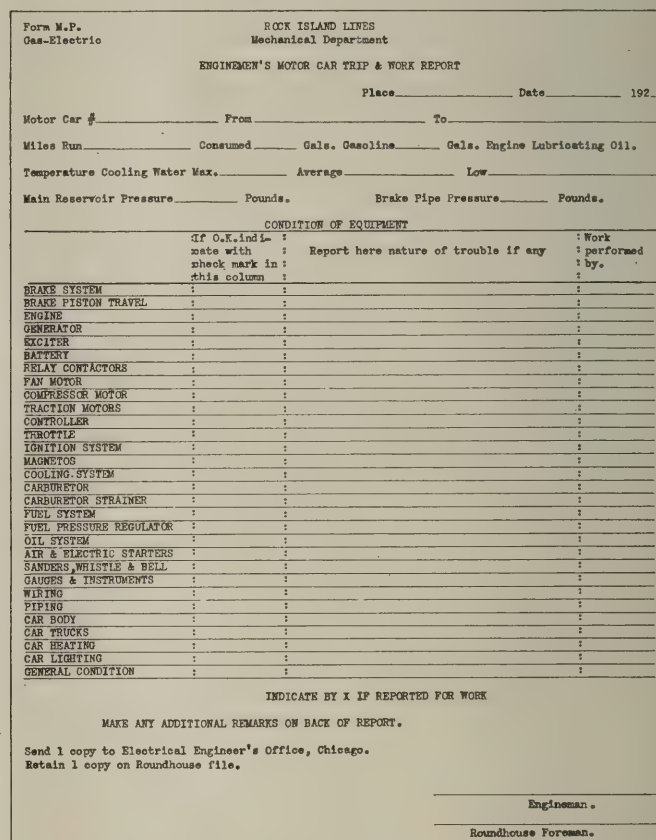


Driver's Seat and Control Apparatus—The Throttle, Electric Controller, Brake Valve and Operating Gages Are Shown

comparatively short time of seven weeks. During this conversion period, the two district supervisors of electrical equipment actively assisted in the work of conversion, so that they could become more familiar with the new equipment.

When the cars were delivered to their various runs for service, they were accompanied by the supervisors, who assisted the instructors of the Electro-Motive Company in instructing the enginemen and maintainers, it being decided to qualify several enginemen and several maintainers for each car, so that some one would always be available when needed to run or work on the equipment. The manufacturer supplied printed preliminary instructions, and now furnishes a complete set of instructions for the operation and maintenance of the equipment, including all necessary references for intelligently ordering repair parts. These complete sets covering the entire equipment, will be issued to enginemen, maintainers and foremen. It is felt that the engineman's trip and work report and the motor car record card illustrated will also greatly aid in the proper maintenance and operation of these cars.

The cars are to be shopped on a 15-month basis for



Form M.P.
Gas-Electric

ROCK ISLAND LINES
Mechanical Department

ENGINEMEN'S MOTOR CAR TRIP & WORK REPORT

Place__________ Date__________ 192_

Motor Car #__________ From__________ To__________

Miles Run__________ Consumed______ Gals. Gasoline______ Gals. Engine Lubricating Oil.

Temperature Cooling Water Max.__________ Average__________ Low__________

Main Reservoir Pressure__________ Pounds. Brake Pipe Pressure______ Pounds.

CONDITION OF EQUIPMENT

	If O.K. indicate with check mark in this column	Report here nature of trouble if any	Work performed by.
BRAKE SYSTEM			
BRAKE PISTON TRAVEL			
ENGINE			
GENERATOR			
EXCITER			
BATTERY			
RELAY CONTACTORS			
FAN MOTOR			
COMPRESSOR MOTOR			
TRACTION MOTORS			
CONTROLLER			
THROTTLE			
IGNITION SYSTEM			
MAGNETOS			
COOLING SYSTEM			
CARBURETOR			
CARBURETOR STRAINER			
FUEL SYSTEM			
FUEL PRESSURE REGULATOR			
OIL SYSTEM			
AIR & ELECTRIC STARTERS			
SANDERS, WHISTLE & BELL			
GAUGES & INSTRUMENTS			
WIRING			
PIPING			
CAR BODY			
CAR TRUCKS			
CAR HEATING			
CAR LIGHTING			
GENERAL CONDITION			

INDICATE BY X IF REPORTED FOR WORK

MAKE ANY ADDITIONAL REMARKS ON BACK OF REPORT.

Send 1 copy to Electrical Engineer's Office, Chicago.
Retain 1 copy on Roundhouse file.

Engineman.

Roundhouse Foreman.

Work Report Form Which Is Filled Out by the Engineman at the End of Each Trip

body finish, etc. The overhauling of the mechanical and electrical equipment will be placed on a mileage basis, as follows:

Complete overhauling, including general repairs to all power and auxiliary equipment—every 200,000 miles. This at least will be a mark for which to strive.

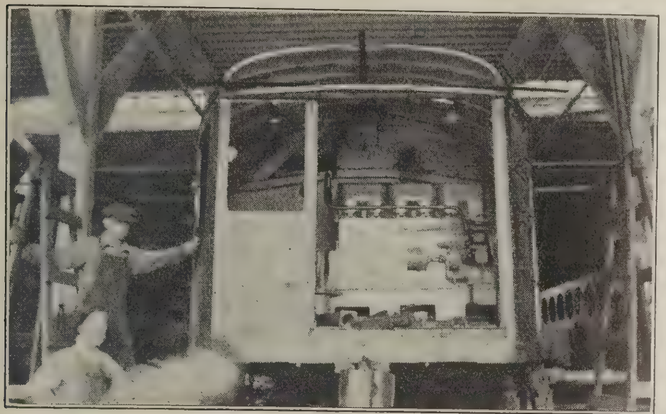
General inspection and valve grinding at terminals, whether needed or not—every 50,000 miles.

Ninety days before the motor cars are to be shopped notice will be furnished the office of the general superintendent of motive power, together with a list of any repair parts that may be needed, so they will be on hand when the car is received at the shop, thus expediting the return of the car to revenue service with the least possible delay. General running repairs, bearing adjustments, etc., will be made whenever found desirable.

A complete stock of repair parts is carried and maintained in the Horton store for the system. The relative simplicity of the equipment is indicated by the fact that this stock contains only 77 items for the electrical equip-

ment and air compressor and 29 items for the Model 106 Winton gasoline engine.

The following list of repair parts is carried and maintained locally; one pair of power truck wheels and axle complete with gear; one pair of trailer truck wheels and axle, journals and pedestal jaws; as well as a few parts for the car body and brake system.



Front End Interior View Showing 175-Hp., Six-Cylinder Heavy Duty Driving Motor—Direct Connected Generator at the Left (Not Visible)

The following list of spare parts is carried and maintained in a spare parts box on each car at all times:

For Electrical Equipment

2 Generator brushes
2 Exciter brushes
2 Fan motor brushes
4 Railway motor brushes
1 Air compressor motor brush
1 Air compressor intake valve
1 Air compressor exhaust valve

For Starting Motors

1 Brush
1 Brush spring
1 Bendix spring

For Engine Equipment

1 Intake valve
1 Exhaust valve
1 Intake valve spring (small)
1 Intake valve spring (large)
1 Exhaust valve spring (small)
1 Exhaust valve spring (large)
2 Valve spring seats
1 Connecting rod bearing, upper and lower half complete.
1 Air starting valve
1 Air starting valve spring
1 Set pump packing

It is believed that the problem of operating and maintaining motor cars will become easier as more of them are placed in service and more Rock Island employees become familiar with them.

The first meter ever used for accurately measuring electric current as supplied from a central station was a chemical device, developed by Thomas A. Edison and first introduced among the customers of his famous Pearl Street Station in New York.

Brush Friction*

Friction is the resistance to motion which takes place when one body is moved upon another, and is generally defined as "that force which acts between two bodies at their surface of contact so as to resist their sliding on each other." The ratio between force of friction and normal pressure is known as the coefficient of friction.

Laws of Friction

When one solid rubs upon another without any lubricant, the resistance offered to relative motion is due either to actual abrasion or to molecular interference between the two surfaces. Even though a metallic surface may appear to be perfectly smooth to the eye, its real condition, if viewed with a powerful microscope, resembles that of a rugged mountain system. When one surface is slid upon another, these surfaces exercise a resisting force. For well lubricated surfaces the laws of friction are considerably different from those governing dry or poorly lubricated surfaces. The value of an oil as a lubricant depends mainly upon its film forming capacity; that is, its capacity of maintaining a film of oil between the bearing surfaces.

A film of oil between the brush and commutator of a motor or generator, besides acting as a lubricant, has the property of increasing the contact drop. However, due to the porosity of the brush and the high temperature at the brush face the oil film usually disappears very quickly, and the injurious effect of oil on mica makes it dangerous practice to lubricate a commutator. On undercut commutators, the practice is even more dangerous, because of the collection of dust and dirt in the slots, which may result in flash overs or short circuits.

Determination of Friction

The apparatus for determining brush friction consists of a specially designed and very accurately balanced copper slip ring driven by a variable speed motor. The brush holders and studs are also of special design, and are very accurately balanced on a pin bearing, the friction of which is so slight as to be negligible, so that only the actual friction is recorded on the fine spring balances used. Thermometers are so suspended as to measure the temperature of the brush as nearly as possible to the brush face. Friction tests are run at different speeds and brush tensions for each grade of brush.

Atmospheric conditions, composition of the brush, brush tension, current density, peripheral speed, composition of commutator or slip ring, condition of commutator, i. e., whether slotted or flush, and temperature are factors which have more or less effect upon the coefficient of friction. Because of these many factors, it is a real problem to obtain accurate figures. The majority of brushes have a coefficient of friction which ranges between .05 and .08.

The hardness of a brush does not indicate its coefficient of friction. The former depends upon the hardness of the particles composing the brush and upon the strength of the binder holding these particles together. Friction depends on the structure of the particles making up the brush and upon the impurities in the carbon or graphite which give the brush an abrasive or cutting quality. It is, therefore, not true to say that a hard brush will wear

*From a Bulletin published by the National Carbon Co.

a commutator faster than a soft brush. In fact, a soft brush will wear a commutator more rapidly than a hard brush with the same percentage of abrasive material, due to the fact that the soft brush wears away more rapidly, which permits the abrasive material to feed down on to the commutator at a more rapid rate. It is possible to get high friction without abrasive action, but it is impossible to get abrasive action without a high friction.

The most common impurities which cause abrasive action are mica, quartz, silica, carborundum and iron oxide.

The heating effect due to friction is a highly important factor in the economical operation of a motor or generator. On machines with flush type commutators, it is sometimes necessary to use a brush with a slight cleaning action in order to keep the mica flush with the commutator segments. On this type of machine, it is sometimes impossible to overload, or even to operate at full load, because of the heating effect. It is true economy to undercut the mica and to use a brush with a lower coefficient of friction.

For example, to show the saving that can be effected in one year's time by using a brush of low friction in preference to a brush of high friction, let us consider a 100 kw. 110 volt machine operating at 3500 feet per minute peripheral speed. The brush carrying capacity being 35 amperes per square inch, brush pressure 2 lb. per sq. in. and the friction values of .6 for the abrasive brush and .1 for the non-abrasive brush. For the rest of the problem, we will assume a 10-hour day, 300 days to the year and a low power value of one cent per kw. hour. A 100 kw. 110 volt generator delivers approximately 910 amperes. At 35 amperes per sq. in. there would be required 26 sq. in. of positive and 26 in. of negative brush surface, or a total of 52 sq. in. The formula derived for the loss by friction is as follows:

$$W = \frac{A \times P \times \phi \times S}{44.26}$$

Where W = Loss in watts
P = Brush pressure in pounds per sq. in.
A = Area of brush contact in sq. in.
ϕ = Hhe coefficient of friction
S = Peripheral speed of commutator in feet per minute.

One watt equals 42.26 foot pounds per minute.

Substituting the values given above for Case I. coefficient of friction .6 in the formula for power loss, we have

$$W = \frac{52 \times 2 \times .6 \times 3500}{44.26} = 4950 \text{ watts.}$$

The loss therefore, is equal to 4.95 kw. which, for 10 hours per day and 300 days per year at one cent per kw. hour, makes a total of $148.50

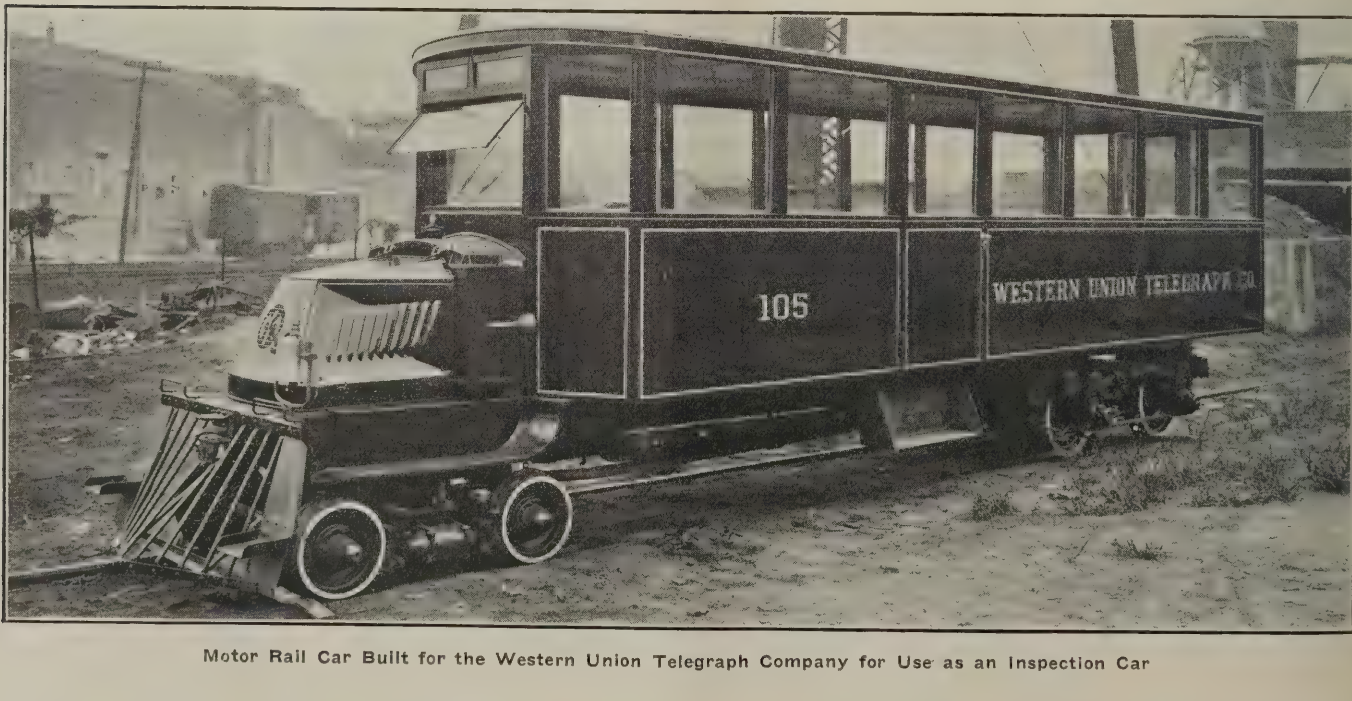
For Case II, the coefficient of friction of .1, the loss per year as given by the formula

$$W = \frac{52 \times 2 \times .1 \times 3500}{44.26} = 825 \text{ watts}$$

For the year, this amounts to $24.75. The amount saved, therefore, by using a low friction brush is $123.25 annually.

Friction and Contact Drop

There is a definite relation between friction and contact drop. Contact drop decreases with an increase of brush pressure, while the friction increases with the pressure. There is a definite point at which the decrease in contact drop is over-balanced by the loss due to the increase in friction. Therefore, in the determination of brush tension, both of these losses should be considered, and the value chosen must effect a compromise between these two losses but the pressure should seldom be less than 1¾ pounds per square inch. For crane motors, mining locomotives, railway motors, and machines for similar service, the pressure ranges from four to six pounds per square inch.



Motor Rail Car Built for the Western Union Telegraph Company for Use as an Inspection Car

Office Lighting on the Missouri Pacific

Changes in Type of Units and Size of Lamps Makes Remarkable Improvement in Illumination

By Louis D. Moore
Electrical Engineer, Missouri Pacific R. R.

THE general offices of the Missouri Pacific Railroad Company occupy the 9th, 10th, 11th, 12th and portions of the 16th, 17th and 18th floors of the Railway Exchange Building, in St. Louis, said to be the largest office building in the world. The building surrounds a central court, and while this court is of fair size and is lined with white glazed brick, the daylight illumination of the interior offices leaves much to be desired, as even on bright days there is only sufficient natural light for the first row or two of desks nearest the windows. In many of the offices it is necessary for most of the employees to work by artificial light during the entire day.

View of Office With Old Equipment Showing Reflectors in Original Position

The general plan of the building provides bays approximately twenty-five feet square, with six outlets per bay, arranged in two rows or three outlets each. This arrangement has been changed in some few places, and the corner bays are each provided with nine outlets, symmetrically spaced. One circuit on the panelboard serves each bay. The ceiling height is 9 ft. 6 in.

The fixtures provided by the Railway Exchange Building Company each consists of an eighteen-inch rigid pendent with spun shadeholder and glass shallow bowl reflector, which is eleven inches in diameter by a little over four inches deep. Originally the Building Company furnished 100-watt type B Mazda lamps for these fixtures, but with the advent of the type C lamp 75-watt lamps were made the standard, the Building Company renewing lamps of standard size free, provided furnished by it originally.

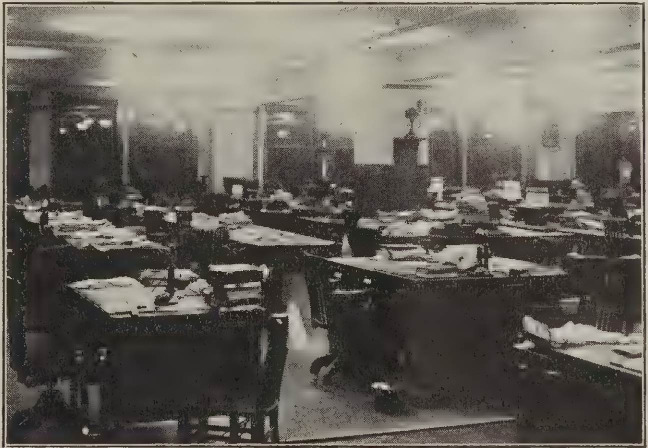
With six outlets in a square bay 25 ft. to the side the spacing in one direction is a little over 8 ft. while in the other direction it is approximately 12 ft. 6 in. With the low ceiling and the unequal spacing the illumination is quite "spotty," or rather, "streaky," as it is fairly uniform along the short spacing but falls off badly between the rows of lamps on the wide spacing. This is shown in the photographs by the shadows between the rows of units.

The lamps supplied by the Building Company are not large enough to provide sufficient illumination for comfortable or efficient work. The intensities vary from one foot-candle to as high as 2.5 foot candles, except where considerable natural light is present. To further aggravate this condition, although the circuit voltage, as tested at many stations, ranged from 108 to 117, the lamps furnished were rated at 125 volts, thus resulting in a decrease in light output of from 25 to 45 per cent.

Although the intensity of illumination with these lamps was very low, the shallow reflectors permitted the filament of the lamp to be seen, resulting in a very bad glare condition. Even with bowl frosted lamps the unshaded lamps in the field of vision caused great discomfort. As a consequence in a great many offices the reflectors were inverted, so as to form a sort of semi-indirect unit. However, as the 75-watt lamps were still used this resulted in still further lowering the intensity of the illumination, while eliminating the glare. In some offices 100-watt lamps were used, but while this helped some the results were still far from satisfactory.

As a result of these conditions there was considerable eye trouble among the employees and much complaint. Finally the management decided that something must be done to remedy the situation and consideration was given to three different propositions:

(1) individual desk lamps;
(2) semi-indirect lighting with dense opal reflectors;
(3) straight indirect lighting with silvered glass reflectors.

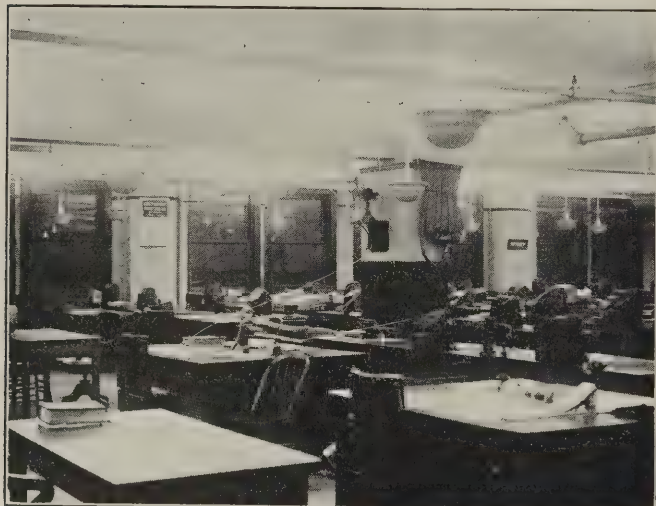


View of an Office With Old Equipment Showing Reflectors in Inverted Position

The individual desk lamps were found to be quite expensive to install and would be inconvenient when changes in force or arrangement of desks were necessary.

From previous experience it was known that the semi-indirect system would require larger lamps than the circuits would stand, requiring about fifty per cent more current for a given intensity than the straight indirect system.

It was therefore decided to install the straight indirect system, using 150-watt lamps. This was estimated to give an average intensity slightly in excess of six-foot candles.



View of Office With New Equipment

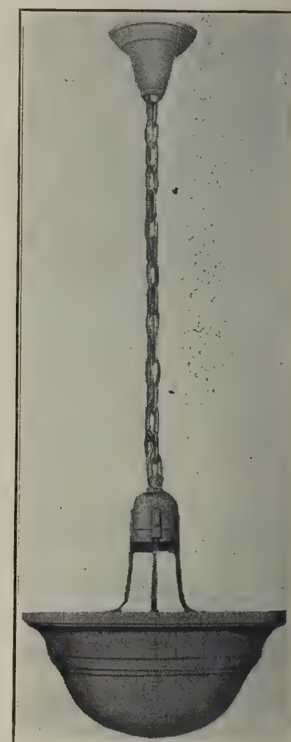
The first office to be selected for the new lighting system was that of the Auditor of Freight Accounts. This is the largest office in the building, occupying the entire west side of the 9th floor, from street to court, and extending around the court both ways for nearly its entire length. Artificial light is necessary all day throughout practically the entire office. The installation in this office consists of 202 fixtures.

Another Office Showing Lighting Effect With New Equipment

The fixtures consist of a 14-inch pan, containing a special silvered glass reflector so designed that there are absolutely no shadows on the ceiling. The pan is suspended by a special hanger from a cast socket housing, the whole being in turn attached to a chain hanger with locking ring for rigidly locking the canopy against the ceiling. The finish is a washable cream, flat tone. Hanging height is 30 inches from top of pan to ceiling. This line of units is a "box line," being stocked, ready packed, by the manufacturer, so that shipments are made on very short notice.

The first installation was so satisfactory that other offices soon followed suit, so that at the present time practically all of the larger offices and many of the smaller ones are lighted with this system, the total number of units installed numbering close to nine hundred, with additions being made every little while. The fixtures are installed by railroad electricians and lamp renewals furnished by the railroad, as the Building Company has refused to renew other than their standard 75-watt lamps.

Another type of fixture consists of a smaller pan, 9¾ inches in diameter, with a somewhat different type of hanging arm. Quite a number of these have likewise been installed.



Type of Indirect Lighting Unit Installed in Most of the Offices

While the spacing is not uniform, resulting in darker spaces between the rows of outlets, the illumination is excellent, the intensity varying between 6 and 8 foot-candles. There is absolutely no glare, either from the units themselves or from glazed paper and copying pencil work. The effect on the employees has been most marked. It is said that some who have been wearing glasses have discarded them, while others who were contemplating using them have found their eye trouble has disappeared.

Some trouble has been experienced in blowing of fuses. In some offices, notably the Freight Traffic Department, an attempt was made to equalize the illumination between some bays with nine outlets and those with six outlets by using 200-watt lamps in the latter bays. As the Building Company refused to install fuses of higher capacity than ten amperes, there was at first trouble with fuses blowing on some circuits. Finally, however, by "juggling" the lamps this difficulty was overcome.

Another difficulty has been high voltage. As previously mentioned, one of the original causes of poor illumination was the use of 125-volt lamps on circuit voltages varying from 108 to 115. Consequently 115-volt lamps were ordered for the new units. This voltage condition continued for some time after the first installation of new units, but after several months the lamps started to burn out quite quickly and voltage tests showed the voltage to be running between 120 and 130. All new lamps are, therefore, 125-volt rating, and while the renewals have been quite heavy for the past two or three months it is believed they will decrease, at least proportionately, as soon as the higher voltage lamps have been installed in all units.

Looking Eastward from Top of Tower No. 7

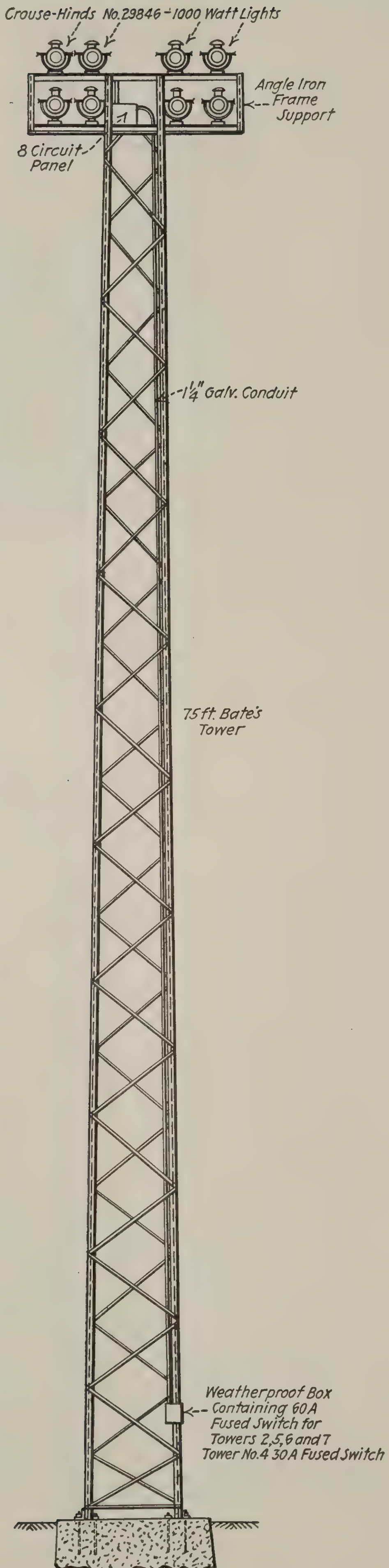
Lehigh Valley Yard Lighting at Manchester

High Voltage Distribution System Has Given Complete Satisfaction During Six Months Period

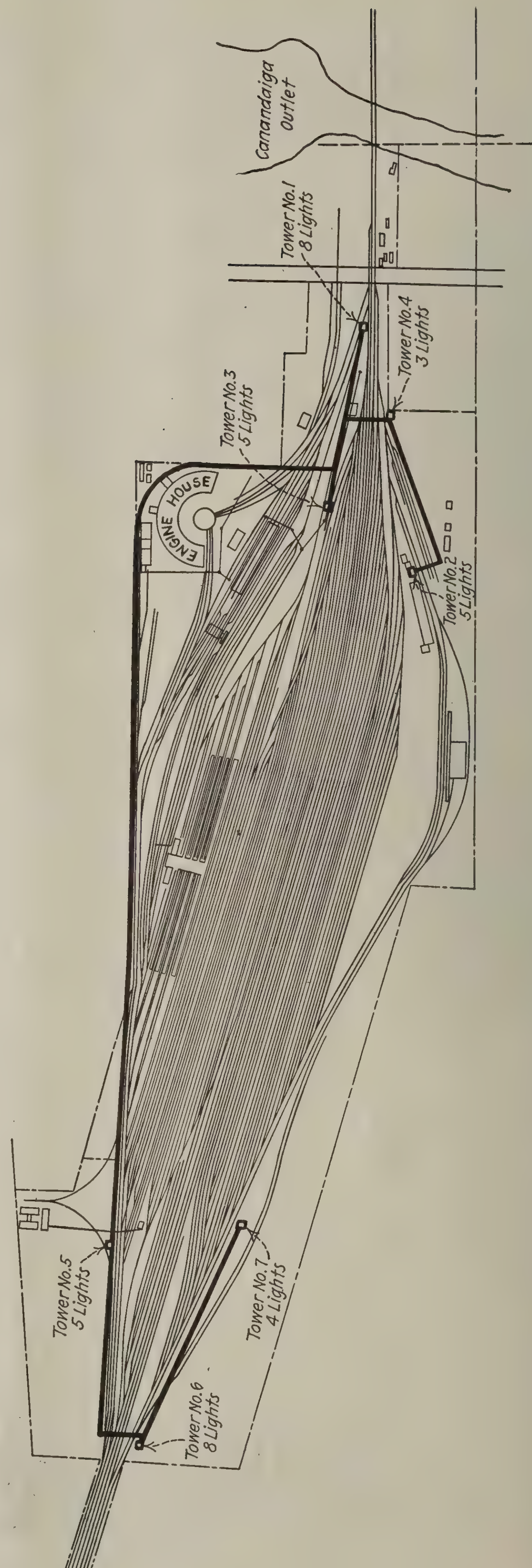
AT Manchester, N. Y., on the Buffalo division of the Lehigh Valley, is installed a system of yard lighting by means of flood lights which has a number of features that are unique.

The general arrangement of the classification yard may be seen from the plan showing the yard layout. It will be noted that there are seven towers upon which are mounted flood lighting units. The requirements for illumination are such that four towers are located on the east end of the yard and three on the west end. Each of these towers is 75 ft. in height and the lighting units are focused so as to give a maximum amount of light upon the working sides of the switches. At the top of each tower is constructed a platform which assists materially in focusing and maintaining the lamps. The towers were made by the Bates Expanded Steel Truss Company but are built up of standard angle irons instead of expanded metal. They were furnished "knock down" to the railroad and were assembled by the railroad construction forces. Each tower is mounted upon a concrete foundation 8 ft.

Rear of Engine House Showing Transformer Bank Where Railroad Lines Connect to the Power Company's Supply



Showing General Construction of One of the Towers



General Layout of Manchester Yard Showing the Location of the Flood Lighting Towers. The Heavy Black Line Represents the 11,500 Volt Line Which Supplies Energy for Lighting and Other Purposes

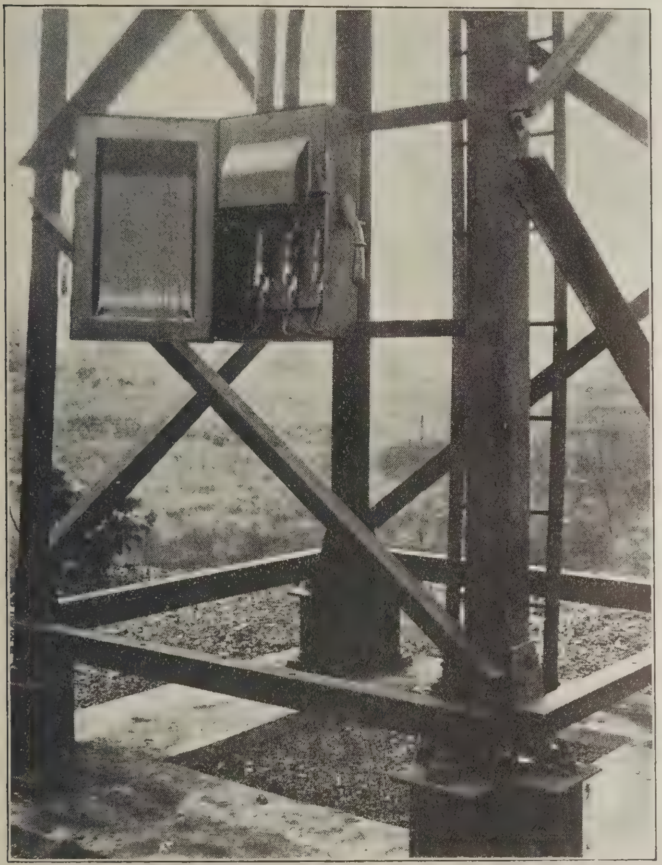
by 8 ft. by 8 ft. in depth with hollow center. The anchor rods run through the full depth of the concrete.

The type of flood lighting units are the Crouse-Hinds R.C.E. No. 29846 in which 1,000-watt lamps are used.

The actual construction of the line and electrical fittings was done by the Robertson Electric Construction Company of Buffalo.

Distribution System

The distribution of electrical energy to the various towers is accomplished by the use of somewhat unusually



One of the Switch Boxes at the Foot of the Towers

high voltage, 11,500 volts being used. The power used in the installation is Niagara Falls power obtained through the Rochester Gas & Electric Co., of Rochester, N. Y. The power line of the latter company connects to the railroad company's line at the point indicated in the diagram. Energy is received at 11,500 volts, 3-phase, 60 cycles. The connection is made through a 15,000-volt type FP-7 pole top oil circuit breaker of the triple pole type having a capacity of 200 amperes. There are two of these switches at the point of connection, one being used for the towers at the east end of the yard and the other for the towers at the west end.

The 11,500-volt line is carried around the yard as indicated in the diagram. Chestnut poles 30, 35 and 40 ft. in length are used to carry the line which is supported on locust pins mounted on yellow pine crossarms. The insulators used in this construction are porcelain and have a voltage rating of 17,000 volts. At the so-called H poles where the line crosses over the tracks the poles are 50 ft. high. The line conductors consist of No. 4 cables comprised of seven strands of hard drawn copper wire. The lightning arrestors which are located on the transformer poles near the towers are the General Electric multi-gap design. The fuses used in connection with the transformers are type CD of the Westinghouse Electric & Manufacturing Co.

At points where the main power line crosses over the tracks the minimum overhead clearance is 40 ft. The main power line dead ends on suspension strain clamps and two porcelain insulators at the H holes each side of the track, and soldered connections are made with loose wires from upper to lower set in respective directions. In no case is the 11,500 line supported from the flood lighting towers. In each instance separate wood holes supporting transformers are located close to the towers and these poles carry the 11,500-230-115-volt transformers. From the end of the high tension line at the transformers the three-wire system is of No. 4 double braid, weather-proof stranded cable. On reaching the tower the low voltage lines enter iron conduit, one line of which extends to a switch box at the foot of the tower while another carries the circuits from the switch to the lamps. The voltage between the two outside wires is 230 and from either outside wire to the middle it is 115 volts, the

Tower No. 1.—Looking Eastward Towards Highway Crossing

voltage at which the lighting units are operated. Following is a list of poles and transformer equipment:

	Transformer Capacity	No. of Lighting Units
Tower No. 1	10 Kva,	8
Tower No. 2	7½ Kva.	5
Tower No. 3	7½ Kva.	5
Tower No. 4	2½ Kva.	3
Tower No. 5	7½ Kva.	5
Tower No. 6	10 Kva.	8
Tower No. 7	7½ Kva.	4

In addition to the flood lighting units the lights for the

yard office are supplied from the transformer and pole No. 1.

At the end of the low voltage line the wires terminate in a Trumbull type A safety switch. These are 3-pole switches and are equipped with 3 fuses.

View of Tower No. 7—Looking Eastward

Inasmuch as the power supply comes from an 11,500-volt feeder that is used to furnish current for other purposes than flood lighting it is impracticable to control the lights from any one central point and hence the individual switches at the base of the towers are opened or closed as required. This plan does not entail any difficulty for it is a simple operation that can be performed by any one and there are always men working in the vicinity of the lighting towers.

That the installation is giving satisfaction is indicated by the fact that there has never been a complaint registered against the lighting by switchmen, engineers or any one else, since the lights were first turned on. Those working in the yard have been very much pleased with the lighting and the entire yard force including engine and switching crews, yard clerks, yardmasters, yard inspectors and repair men are all able to do their work more easily and safely.

The damage done to equipment formerly by "cornering" cars which had not run into clear has been practically eliminated as the men are now able to see them. The lighting also assists in the protection of freight against car burglary in the yards.

The contract for the work was let on January 17, 1925, but some of the work was started during December. The system was completed and put into service on March 18, 1925. The approximate cost of the installation was $15,000.

An increase in the monthly bill for electric energy does not necessarily imply an error on the part of the meter. The weather, for example, has a marked influence on the use of light. Considerable variation exists between days, months and quarters, but the yearly averages of dark weather much more closely approximate each other, an average of 38 per cent being a representative figure.

Times (London) Photo

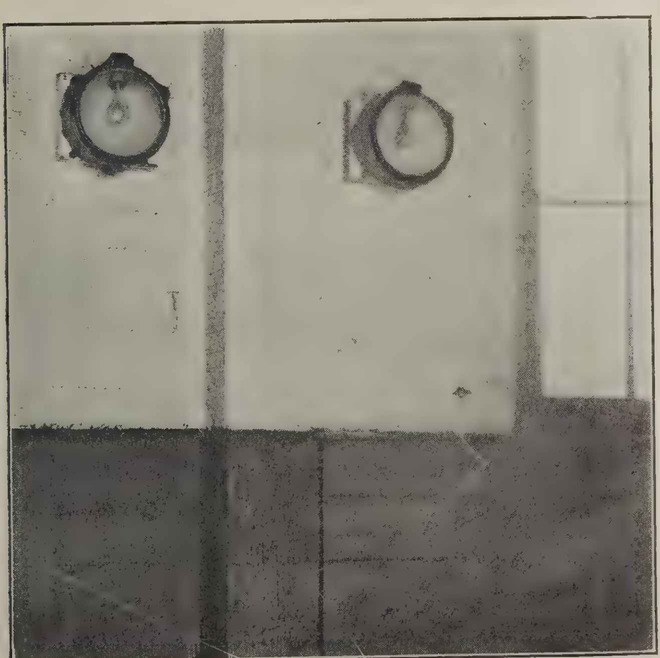
Why Commutation Rates Are Low in Paris

Economical Enginehouse Lighting on the St. Paul

Conduit Life Lengthened by Placing Lighting and Extension Cord Circuits Outside of Buildings

TO eliminate as far as possible the destructive corrosive effects of the hot gases found in roundhouses, some roads have made it a practice to install most of their lighting conduit outside the building along the wall or on top of the roof. The conduit can be placed in such position as to be more accessible than if it is placed inside the building. Another feature of this outside location is that it permits frequent painting of the conduit with consequent increase in useful life. The Chicago, Milwaukee & St. Paul has two roundhouses in the Chicago terminal district, the lighting installations in which are designed along the aforementioned lines. At the Galewood (Chicago) enginehouse, the lighting circuits are carried around the outer wall in ¾ in. rigid metal conduit just below the eave. Open wiring carried on porcelain knobs below the eaves serves a similar purpose at the Bensenville, Ill., roundhouse.

Open Wiring Below Eaves Carries Lighting Circuit at Bensenville



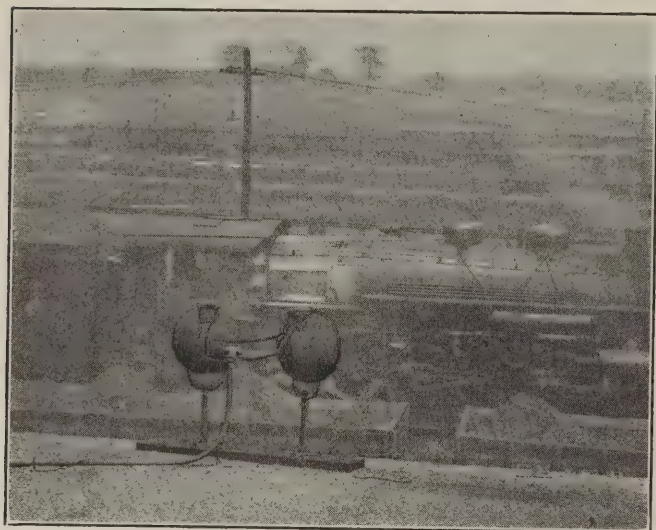
There Are Two 100-Watt Projectors on the Back Wall Between Each Stall of the Enginehouse

An individual circuit for each lamp, of which there are two between each stall mounted on the back wall, is carried in a vertical piece of conduit about 12 ft. long. The upper end terminates in a "T" conduit fitting just below the eave, while the lower end runs through the brick wall and enters the back of the reflector mounted on the inside of the wall. No conduit is carried inside the building for lighting purposes; however, the extension cord circuits are carried in short pieces of conduit running from the roof down the columns to the receptacles. A

The Extension Cord Circuits Are Carried on Roof of Enginehouse—Conduit Shown Has Been in Service Eight Years

Top of Coaling Station Serves as Advantageous Location for East Bank of Floodlights at Bensenville

separate circuit is provided for the extension cord receptacles and this current is carried in conduit supported about two inches above the roof of the house on wooden spacer blocks. It is not a difficult matter to paint the conduit when laid on the roof in this manner. To keep rain out of the conduit fittings it is standard practice on this road to place a 1/8 in. sheet rubber disk below the covers to make a watertight seal. The present conduit

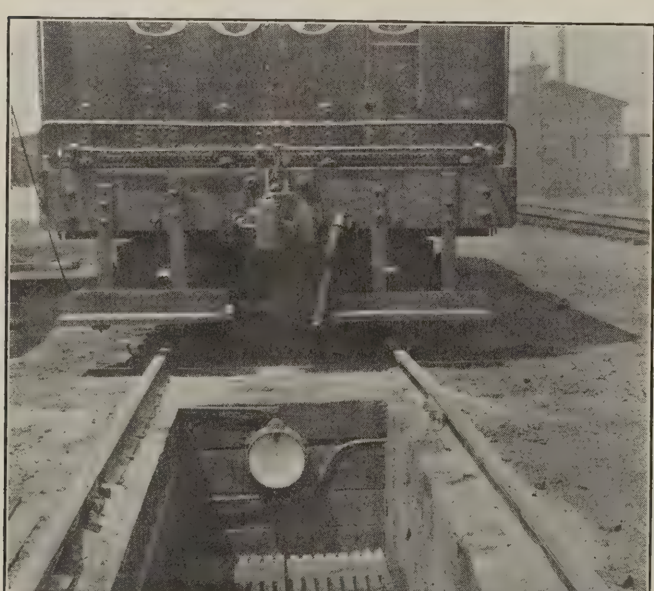


The Cinder Disposal Pit Is Lighted with Two 500-Watt Projectors Mounted on the Roof of the Office Building

on the roof of the Galewood enginehouse has been in service for eight years and is in good condition.

Mounting of 100-Watt Wall Projectors

In order to keep the lamps below the smoke zone inside the enginehouse, the projectors which are Crouse-Hinds 100-watt 220-volt units are mounted at such a height that



Locomotive Inspection Pit at Bensenville Is Lighted with 100-Watt Projectors at Each End

the lamp filament is exactly eight and one-half feet above the floor. To mount these units, a board slightly larger than the projector is fastened to the brick wall with four Pierce expansion bolts. Then the projector is held against the board at the proper height and the conduit entrance hole at the back of the unit is spotted on the wood panel. After locating this hole it is drilled with a brace and bit and then the brick wall is drilled to receive the lower end

Conduit Is Used to Support This 500-Watt Floodlight Mounted on Car Body Roof

of the vertical conduit on the outside of the wall. Two lock nuts, one inside, the other outside of the projector cover, hold the end of the conduit. Four brass screws hold the projector securely to the mounting board. At the present time there are only six lamps on a branch circuit tapping off the main lighting circuit through a fused

A Bank of Five 1000-Watt Floodlights Furnishes Illumination for the Turntable and Approach Tracks

cut-out in the roundhouse. The main lighting circuit is controlled through a 100-amp. Square D safety switch in the power house, all lights being turned on and off at the same time by the station operator. This eliminates any chance of lamps burning in the daytime through oversight on the part of enginehouse attendants. All lamps, including those for roundhouse lighting, extension cords, and yard lighting are 220-volt type as this is the rating of the d. c. generators in both power houses.

Extension cords are provided made up with an Oliver SRBB-13 plug at one end and a No. 60666 Parker moulded mica socket at the other, fitted with a No. 1430 Holdfast lamp guard. The flexible cord is No. 18 Tirex.

At Bensenville the lighting units in the enginehouse are mounted in the same manner as those at Galewood. However, instead of using conduit under the eaves for the lamp circuit, open wiring supported on porcelain knobs is carried in the same location.

Floodlighting Projectors are Mounted High

The turntable, cinder pits, coal shed and approach tracks are lighted at night by a well designed flood lighting installation. A battery of five 1,000-watt, 220-volt, Davis flood lamps is mounted on top of an 80-ft. pole at the enginehouse to illuminate the turntable, cinder pits and approach tracks. A similar bank of flood lighting projectors is mounted on a special platform built on top of the coal chute to light up the east end of the layout. Two 500-watt Davis projectors are mounted on the roof of the master mechanic's office to increase the illumination of the cinder pits. At night the yard in the vicinity of the cinder pits is illuminated enough to permit working around the locomotives with almost the same degree of safety existing under daylight conditions. All floodlights are controlled from the power house.

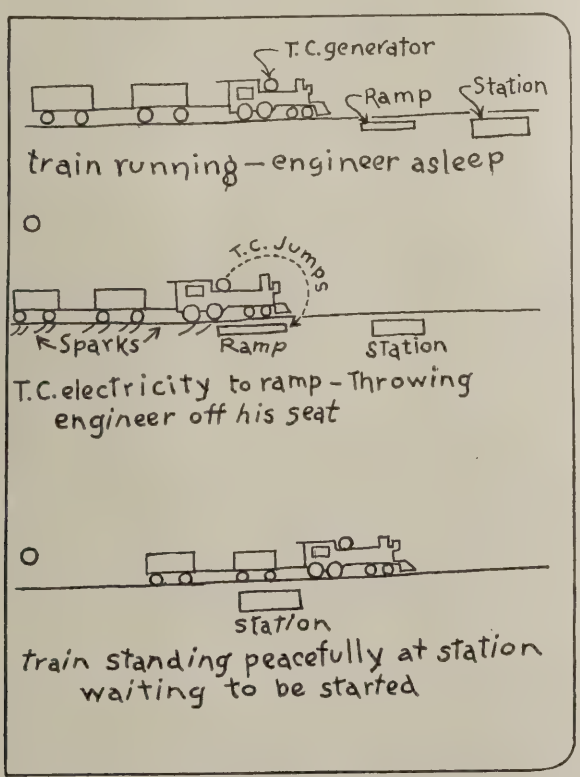
An inspection pit is well lighted by using a Crouse-Hinds 100-watt projector at each end of the pit. The method of mounting these units, which are similar to those used in the enginehouse, is shown clearly in one of the illustrations.

To realize the full efficiency of this lighting installation, a proper schedule of lamp and reflector cleaning is of fundamental importance. It is the practice at the present time to clean all lamps and reflectors at least once a week. For this purpose it has been found that wood alcohol, diluted with water to the extent of one part water to three parts alcohol, is a good cleaning agent.

Hinkey Dee Discovers a New Kind of Electricity

Our Old Carlighting Friend Tells About the Strange Antics of T. C. in Its Latest Application

YES sir! and "I don't mean maybe," when I say I no all about every thin. Nothin is simple when you no how and believe me, I no how, even if I don't like to say it. Guess you all no I ain't been writin much lately and the reason is because some fellow was after my job, so, to prove to him that he didn't do nothin, I just stopped writin all about what I no. My grandmother always told me, "be sure you rite and then stop." It works every time because in spite of all I no, and as hard as he tried, he didn't get me job and he only got me bosses job which doesn't make as much as me, because I work over time a lot, and don't worry. I certainly am glad about the whole thing and it goes to show that if you no it all, you stay rite where you are and nobody can move you, even if they don't no nothin.



A Page From Hinkey Dee's Note Book Shows How the Wonderful T. C. Electricity Works

By golly, I nearly almost forgot to tell you about me, hear I have been writin about everything else and never thought to say anything about all I no and who I am.

But after all its told to you, I guess everybody nose me, but the new birds on the railroad, these locomotive head lite and train control guys may not no who I am. So, for there sakes, I am Hinkey Dee, I no everything there is to no about car lightin, also locomotive head lites and also train control. Yes, I don't bragg about it, but I no the circuits on a Pullman Car from A to Z. Of course, I got to hand it to Jimmie Goat and to Eddie Ram also. They nose nearly as much as me about car lightin but when it comes to bare facts they don't no nothin.

Speaking about noin it all, outside of myself there is one railroad boy that I have to give the high hat, and I don't mean the brown derby because he and I no a lot. I no it all and he nose more than most people, his name is Skoop Ramp. For example there is a new kind of electricity out now, yes, it just came out when so many people got to bein hurt and killed and all on the railroad, they had to do somethin so they brought out a new kind of electricity. Thats where Skoop Ramp gets the high hat because he and I are the only one who really nose all about this new kind of electricity. A lot of these fellows who have swelled heads and hate them selves will tell you about A.C. electricity and D.C. electricity but you don't here nobody tellin you about T.C. the new kind of electricity. That's why Skoop Ramp and I get the high

hat when it comes to noin it all, because we are the only ones who noes it all about T.C.

Now for the sake of those who don't no much, I'll explain all about T.C. electricity, and believe me, I can. You see, A. C. electricity is one kind of electricity and D.C. is another kind of electricity just like day and nite but T.C. electricity is an all together different kind of electricity and is not the same as D.C. is and is not the same as A.C. is, no its different.

You will all no doubt remember what I told you about car lightin, you no in car lightin, the electricity is not only in the lamps but it is also everywhere, in the batteries and tanks under the car. Also in locomotive head lites, the electricity is not only in the lites but also in the steam fan which pushes the generator sometimes called the steam turbine. So you see this kind of electricity is not only one place but everywhere, in the lamps, in the lites and all over. But T.C. electricity is different, it ain't every where like A.C. and D.C. electricity.

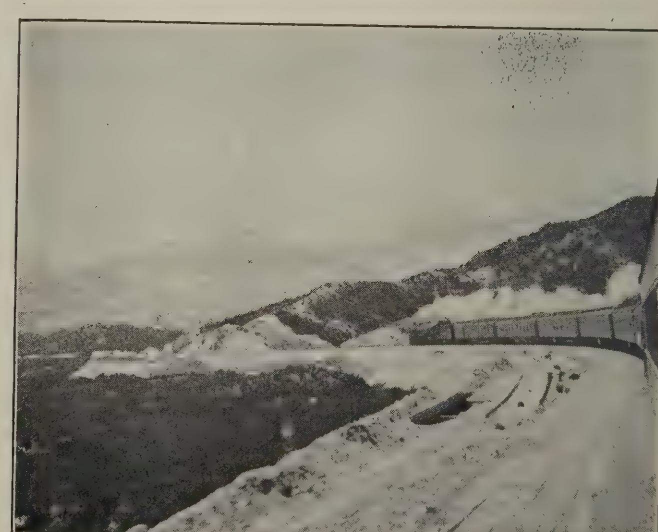
Another Page From the Note Book Shows What Takes Place Inside the Cab

No sir, and "I don't mean maybe," T.C. electricity jumps, that is, it is only one place at a time and then it jumps, and don't go any particular place. For example it is used in Train Control and thats why it is called T.C. because it jumps on and off the train instead of the engineer, and doesn't get hurt, I mean nobody gets hurt. If its on the track and the train goes by to fast, it just leaps or jumps on the engine and slows it down, then the engineer nose he's been going to fast and starts up again. No wires are used when the T.C. electricity jumps. There's also another funny part about the new T.C. electricity because you can't see it but you certainly do no when it works.

If it wasn't for T.C. there wouldn't be no train control and the engineer would have to still run the train. Speaking about train control there is one bird who sure nose train control and his name is Skoop Ramp. I no he nose all about train control because he explained it all to me when he worked on locomotive headlites. There really ain't much to no about train control or locomotive head lites either because theres no difference. Thats how Skoop Ramp got his name, the water is skooped to tender and boiled for the steam engine which drives the generator. Then the Ramp which is located on the track takes the current "T.C." as it jumps from the generator which naturally completes the circuit, because the Skoop and the Ramp both connect the engine and the track through the air. Now when you no this, the rest is simple because it all works like the annunciator on a Pullman Car when you touch the button to call the porter, but differs in that it tells the engineer what he's doin instead of tellin the Pullman Porter what he is to do. Then if the engineer wants to take a nap he is always safe and can't get hurt, because the engine only has to be started and then the Ramp looks after it, and keeps it on the rails and from bein bumped off and all.

For example, one day Skoop Ramp took me with him one day to show me how it worked. We got into the cab and all and Skoop started the engine, we had lots of water in the tender and so we all went to sleep. Suddenly the T.C. jumped from the generator and shot into the ramp and we all slidd of the seats onto the cab floor and just as we all got up and looked out the cab window, the train was stoppin at the station and we were all on the job ready to start her when the conductor pulled the cord. Now ain't it simple when its all told to you. There's not much to it because if the ramp doesn't throw the engineer off the seat, then you always no it ain't workin rite and the skoop ain't gettin enough water needed for the head lites.

Skoop Ramp will get sore when he nose I have told every body all about it but its really nothin compared with car lightin because car lightin is for the passengers while head lites and train control is only for the engineers health, protection and comfort.



A Santa Fe Train Descending Western Slope of the Sierras into Los Angeles

Welding in Railroad Shops*

By E. Wanamaker
Electrical Engineer, Chicago, Rock Island & Pacific Railway

INSPECTION OF WELDS

(a)—Preparation for Welding:

On railroads, the preparation for welding is done in accordance with standard instructions for the principal applications and local supervision is responsible for adherence to standards, the same as any other work.

(b)—Length of Arc:

In general, whether or not the proper arc length has been maintained is best determined by visual inspection of the finished job, but, of course, can also be determined periodically during the performance of welding by observance of arc voltage, which is nominally 20 volts, for the usual run of work.

(c)—Penetration:

As in the case of arc length, visual inspection of the finished job can give some indication of penetration by the appearance of the deposit—that is, whether there are any overlappings of the added metal. Inspection for penetration may also be made periodically during the process of welding by observance of the crater from the base metal.

(d)—Fusion:

Aside from the character of the metal, from which a weld is formed, it may be said the quality of the weld is determined entirely by the thoroughness of fusion between the metals to be joined, and to some extent the character of the metal would be altered by variation in the degree of fusion. It should be kept in mind that thorough fusion is the principal objective for welding, and the thoroughness of fusion naturally is subject to alteration by any one or all of the variable conditions involved in welding, such for example as length of arc, cleanliness, arc current, which are conditions largely under control of the operator. In addition, it is also affected by the flow or penetrating quality of the wire employed and possibly the current and voltage characteristics of the welding circuit. There is, however, little to be feared from the latter feature as most of the modern equipments provide the proper current and voltage characteristics. In conclusion, proper inspection of conditions enumerated would determine the thoroughness of fusion.

(e)—Porosity:

Inspection required for this work varies with industries. On railroads, it is determined usually by hydrostatic test.

(f)—Visual Inspection of Finished Jobs:

Visual inspection of finished welds, of course, furnishes some indication of the quality of the work and assuming only the surface portion of the weld indicated good welding and the remainder were poor, it, at least, indicates that the operator is competent to perform good welding. Whether he does this consistently must of necessity depend either on close supervision and inspection in the application of welding or upon the operator's record.

(g)—Photographs:

On the railroad work, with which I am familiar, micro photographs are used generally in connection with tests, either for contemplated applications or to determine the cause of failure and in some instances to examine workmanship.

TESTING SKILL OF OPERATORS FOR SPECIFIC WORK

(a)—Handling Torch or Electrode:

Most of the inspection used for determining the quality of welds is also applicable for the testing of skill of operators. For instance, the handling of the torch or electrode could be determined by arc length, penetration, thoroughness of fusion, etc.

(b)—Selection of Current Voltage and Size of Rod:

Selection of current is usually given in standard instructions—that is, the nominal current for a given size electrode, and the size electrode for a given section or mass, in the standard instructions. There is of necessity considerable latitude in the choice of current and size of electrodes occasioned by the conditions under which the welding must be done, such as position of the work, and the thermal capacity of the parts, rate of heat conduction, etc.

(c)—Adjustment of Tips and Pressure:

In general, choice of tips are determined by the same conditions as the choice of current and electrode sizes for arc welding; the pressure varying with the make and type of torch usually furnished by the manufacturer.

(d)—Length of Arc:

As given under inspection of welds, the length of proper arc is determined by the arc potential, the degree of fusion or penetration, assuming the electrode current density of a proper value is employed.

(e)—Physical Tests to Determine Quality of Welding:

The tests for operators vary widely with the different roads. Some require no physical test if the operator fulfills qualifications with respect to the preparation of work, length of arc, penetration, choice of current, etc., where in other cases, in addition, a rough physical test is conducted by testing specimens, usually pieces of boiler plate welded together and tested to destruction by bending under the hand or steam hammer and noting the degree of bend and the structure of the weld metal, and in still other cases, samples are submitted to the laboratory for the usual tensile test.

(f)—Speed of Welding:

The consistent rate of welding is determined not only by the skill of the operator, but also by the nature and location of the part or parts to be welded, and for practical purposes can only be judged by the supervision directly in charge which is the usual procedure.

CONCLUSION

It might be well to say that at least insofar as the Rock Island Lines is concerned, we have found—after necessary and due experimentation with any new possible job that may have presented itself, or have been developed in an effort to seek a more satisfactory and more economic method—that it is first necessary for general supervisory officers in charge, with the assistance of those who have direct supervision over welding matters, to develop standard methods for preparing, performing and inspecting the entire welding job or operation, in line with standard general welding instructions and specifications. Such procedure carefully followed results in what may well be termed commercially successful welding.

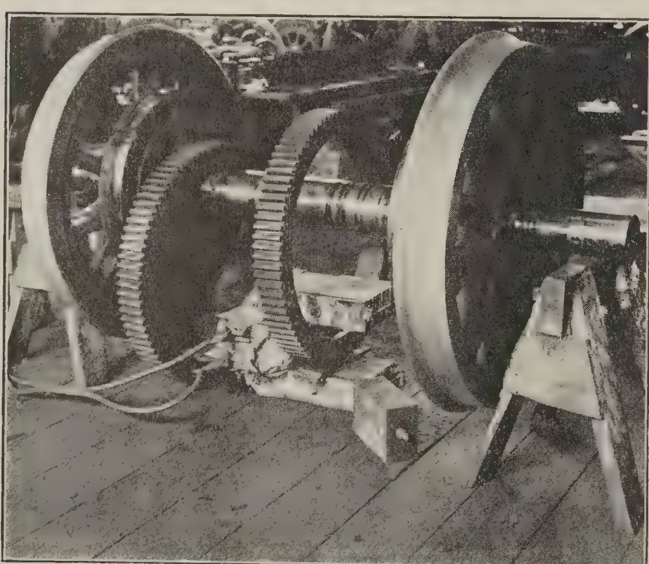
* From the Journal of the American Welding Society.

Electric Gear Heater

By F. W. Bellinger

Electrical Superintendent, Butte, Anaconda & Pacific Ry. Co.

An electrical gear rim heater has been developed in Anaconda shops of the Butte, Anaconda & Pacific for expanding gear rims on electric locomotives. The heater consists of a transformer with a tapped 440-volt primary winding. One side of the transformer core can be removed so that the gear rim can be placed as shown in the illustration. After the gear rim has been placed as



The Heater Insures Uniform Application of Heat

shown, the removable section of the core is replaced thus closing the magnetic circuit. When the current is turned on the primary, the gear rim forms a short circuited secondary and the short circuit current provides uniform heat and corresponding uniform expansion. After the required temperature has been reached, the gear rim is placed on the gear rim center and allowed to cool.

Gears which have been worn sufficiently to require replacement are removed with a cutting torch and chisel. The cutting torch is used to cut the gear rim down to about one-quarter of an inch from the rim center, after which a chisel is used to cut the remaining section of the rim.

The core of the transformer is made from transformer iron of .017-inch thickness which had been relegated to the scrap heap. The shape of the core was predetermined as was the cross sectional area due to the limited quantity of iron at hand. The core stands 15¼ inches high by 10½ inches wide and 18⅞ inches long; the opening for the removable section measuring 7 3/16 inches. The removable part has a slightly larger cross sectional area than the balance of the core.

The winding is made from ribbon wire obtained from an old lifting magnet and measures ⅛-inch by 35/64-inch and is insulated with double cotton. Several coils were put on but only five have have been used. These are made up of 10-10-11-11 and 12 turns respectively, all of which are connected in series. When heating gear rims, having a cross sectional area of 12.5 square inch and a circumference of 109.95 inches, taps 3 and 5 are used (34 turns). For other work, such as expanding rings of various dimensions taps 1 and 5 (54 turns) are used. In each instance the primary potential is 440 volts.

This transformer works very well for expanding gear rims and has been used for applying heavy locomotive tires having a diameter of 47 inches and a cross sectional area of 20.25 sq. in. It is evident, however, that the radiation losses are very great and in order to get the best results it has been necessary to cover the exposed portion of the tire or rim, as the case may be, to save time and energy.

Alternating Current for Car Lighting at Terminals

By Robert Yount

Electrician, C. R. I. & P.

Alternating current is used for lighting cars in the terminal by the Chicago, Rock Island & Pacific at Memphis, Tenn., with results which have proved satisfactory in every way.

A 220/32-volt transformer of 5 kw. capacity has been installed for the purpose of supplying light for interior cleaning and polishing of parlor cars and diners. The cars for which this lighting arrangement was made are short run cars with heavy demand for lights and have long cleaning periods at night.

To avoid higher setting of regulators and consequent damage to equipment much additional charging of the batteries by the old familiar charging cable was necessary.

The transformer which is being used was procured as junk and was rewound by the local electricians. It had been a 2200/220-volt transformer and the rewinding was very easily accomplished with ordinary shop facilities.

It is mounted on a pole in the yard and the cars are placed near by every night.

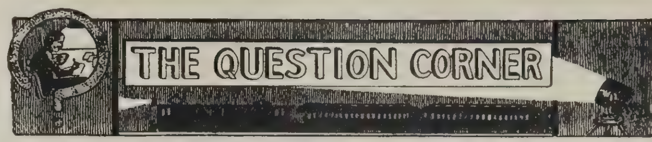
The secondary 32-volt side of the transformer is connected to the car through the trainline. Flexible cable of suitable length is used for this purpose and a slip connection has been provided which will part the cable should the car be moved unexpectedly. A standard train line connector plug is attached to the end of the cable.

It has not been found necessary to fuse the secondary side of this transformer, as all primary circuits on the cars are fused at the distributing panel, these fuses also amply guard against any damage that might be caused by accidental closing of both the battery switch and train line switch. Additional cars may be lighted in this manner by trainlining in the usual way.

The 32-Volt Transformer Is Mounted on a Pole in the Yard

While lighting a parlor car and diner in this manner, with an abundance of light on both cars, it has been found that only 5.5 amperes at 220 volts is being used. At this rate a very substantial saving is being made over the old method of charging the batteries, and proper lighting performance is assured before leaving time of the train every morning, and at the same time the battery is not abused.

One hundred and ten volt alternating current is sometimes used for lighting convention sleepers. When this is done it is necessary to replace the lamps and to disconnect the fans. When the 32-volt current is used the lamps are not changed and no provision is necessary for the protection of the fans. For purpose of test some of the fans were connected to the 32-volt alternating current and although left in operation for several hours they showed no signs of overheating.



Answers to Questions

By what different methods can you tell when a storage battery has been brought up to a full state of charge?

When a Battery Is Charged

There are three methods by which the state of charge of a battery may be indicated:

(1) The voltage on charge or discharge; (2) specific gravity of the electrolite; (3) the indication of the resistor type ampere hour meter connected permanently in the battery circuit.

These three methods cannot be depended upon with the same degree of reliability. The voltage reading on charge or discharge is only a rough indication of the state of charge of the battery. It depends upon a number of features, such as the charging current rate, temperature, strength of electrolite, condition of the plants, etc. The open circuit voltage of a battery means nothing. Always let a battery charge five or ten minutes before taking a reading. Numerous devices have been designed to cut off the charge automatically when the voltage of the battery reaches a certain value, but because of the uncertainty of the voltage indication these devices have not been successful.

The specific gravity readings may be taken as a very accurate indication of the state of the battery charge, provided, however, that the level of the electrolite in the pilot cell is maintained at a certain height. When this varies an inch or more as it does in car lighting service, the specific gravity readings may give a misleading idea of the condition of charge. The temperature of the battery must also be noted and proper corrections in gravity made.

The resistor type ampere hour meter permanently installed in the battery circuit, which regards all previous discharge and runs 20 per cent slower on charge than on discharge, automatically providing a charge in excess, should give a fairly reliable indication of the condition of charge. It should be pointed out, however, that the actual ampere hour efficiency of a battery depends altogether upon the service which it receives. In other words, a battery which is frequently discharged or charged intermittently, will show a fairly high battery efficiency, even as high as 99 per cent in extreme cases. On the other hand, a battery which received very little discharge or is allowed to stand idle for long periods may show an extremely low battery efficiency, and the ampere hour meter set to provide only 20 per cent excess may give entirely wrong indication.

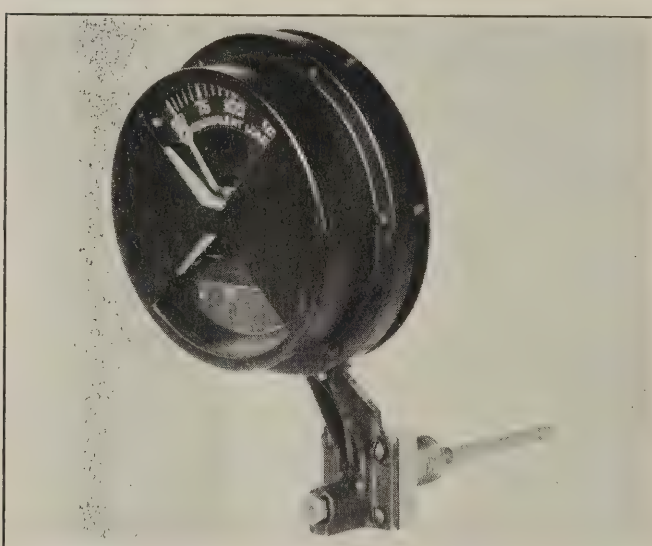
The experience of operating a large number of axle car lighting systems on the ampere hour meter principle will undoubtedly show what ampere hour efficiency should be assumed and the meter can then be set to operate at that value. Even though the meter be set to provide twice as much voltage as is actually required, that is, if it were set for 30 per cent overcharge where actually only 15 per cent were required, this error would probably cause only a slight overcharge in ampere hours, for this excess overcharge would be simply 15 per cent of the total ampere hour discharge.

NEW DEVICES

Transformer Load Indicator

A load indicator for 60-cycle, 2,300-volt, subway type distribution transformers from 15 to 200 kva. inclusive, known as the type B-2 Thermotel, is now being manufactured by the General Electric Company. This instrument is similar to the thermotel for pole type transformers and was designed as a convenient and reliable means of making load surveys.

It is designed to factor all the several variables on which the output of a transformer depends, including (1) the Kva. rating of the transformer; (2) the load; (3) the duration of the load, and (4) the temperature of the surrounding air, usually referred to as the ambient temperature. The percentage of available transformer output which is being utilized is also indicated.



Load Indicator for Transformers of 50 to 200 KVA, Capacity

This instrument indicates underloaded as well as overloaded transformers, together with load conditions at the time of resetting, and exposes an easily distinguishable danger signal when safe load conditions are exceeded. An important feature is the ability to differentiate variations in ambient temperature accurately.

The device consists essentially of two thermometers connected in series; one, of the capillary tube type, is immersed in the oil, and the other, of the bimetallic type, is located in the external case and acts as a corrective for the ambient temperature. The combination actuates the hand and danger signal.

The external case is of brass, finished in black baking japan and thermally insulated from the radiant heat of the transformer by a metal screen and air space. This case is riveted to a bronze casting through which the capillary tube passes.

Installation requires but the removal of the lower oil sampling plug, after which the thermotel, which is provided with the necessary fitting, is screwed in. An auxiliary sampling plug is also provided on the instrument to permit the checking of the oil level in the transformer as before.

The hand is of the maximum reading type and records the maximum percentage of the transformer's capacity which has been utilized since the last resetting, the scale being graduated to read between 50 and 125 per cent transformer capacity. The semaphore indicating an overloaded transformer is normally not in sight until 100 per cent of the transformer capacity has been exceeded, when it drops into view.

Power Operated Reamer Drive for Bench Work

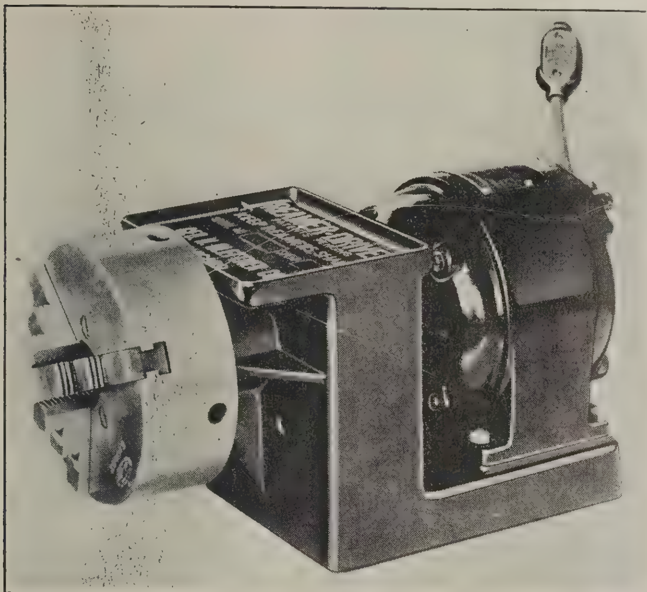
A new power machine designed to grip firmly and to electrically operate reamers when reaming such parts as bushings, spring shackles, connecting rods, pistons and the like, is now being manufactured by the George H. Blettner Co., Chicago, Ill. This machine is powerful enough to remove .020-inch stock with each pass of the reamer from bronze bushings up to 1½-inch and babbitt up to 2½-inch in diameter. The spindle is provided with a geared scroll chuck which accommodates reamer shanks up to 1¼-inch in diameter.

The adaptability of this electrical device to bench work is the outstanding feature, and makes it a handy tool in machine shops, and automotive and railway repair shops. It is easily and quickly mounted on the bench and occupies a space of only 7 by 15 inches.

This machine is operated by means of a Westinghouse ¼-hp. motor mounted on a base provided for it. A regular running speed of 38 r.p.m. is accomplished by means of a balanced gear reduction running in oil. All

gears are totally enclosed in suitable casing to protect the operator at all times.

This machine is simple in design, sturdy and compact

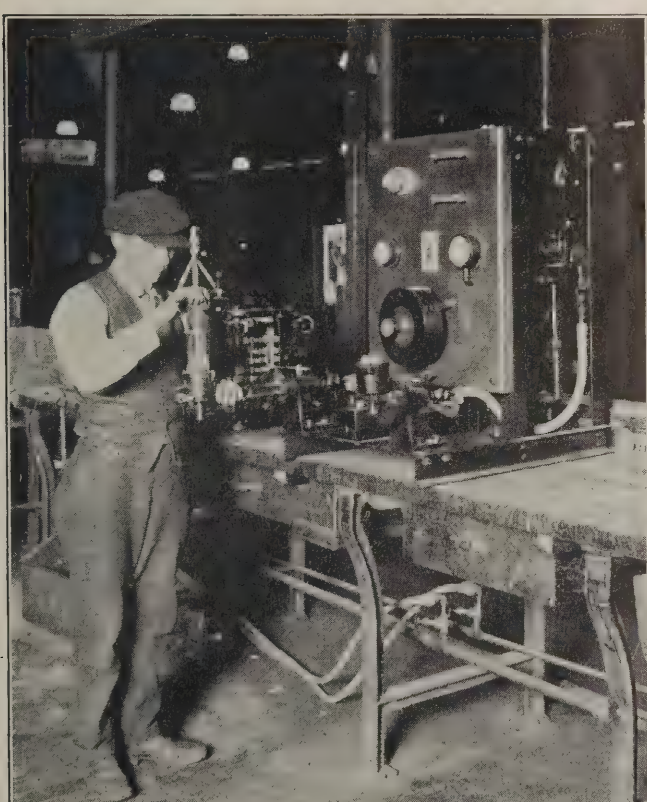


The Complete Machine Occupies a Space of Only 7 by 15 Inches

in construction and weighs only 80 pounds prepared for shipment. It is finished in black enamel to give it a pleasing outward appearance.

Maintenance Outfit for Magnet Valves

A complete outfit has been developed by the Westinghouse Electric and Manufacturing Company for the thorough and systematic overhaul of electro-pneumatic



Maintenance Outfit Set Up with Provision for Working Two Valves at Once

valves. This equipment permits of accurate adjustments which are prime requisites to proper valve performance in their important functions in switch groups, reversers, pantagraphs, cam groups, sanders, whistles, etc.

The outfit consists of brackets and adapters for holding the valve while it is being overhauled and undergoing tests, a rheostat for regulating the testing voltage, a testing switch, necessary indicating instruments and pneumatic equipments consisting chiefly of a reducing valve and an air reservoir.

It has been found to be of advantage to the maintenance forces not to assemble this overhauling equipment in any particular ready-to-use manner. For this reason suggestions and diagrams for arranging the outfit in bench form, accompany the equipment.

The outfit is arranged for duplicate operation, in that one valve may be tested while another is being adjusted or the valve seat ground. Provision is made for fastening the valves to the bench in such a way that they can be readily turned to any convenient working position.

Portable Curve Drawing Instruments

Two new types of portable curve drawing instruments, the CP-4 and the CP-5, have been introduced by the General Electric Company. These instruments are intended for alternating current work, the first being equipped with a Chelsea clock paper drive, and the second with a Warren motor. With them, chart speeds of one, three, six or twelve inches per hour can be obtained and

Portable Polyphase Wattmeter

all instruments are equipped with a gear shift which changes from inches per hour to inches per minute.

The new instruments are high torque devices; damping is unaffected by temperature and is sufficient for rapidly fluctuating loads, such as electric furnaces; pen points have sufficient force to minimize errors as a result of friction with the paper; instruments are shielded from stray fields, and the reroll cannot be damaged by pulling out. The instruments are small, light in weight, of high voltage capacity and have small internal losses.

The complete line comprises ammeters, voltmeters and single phase and polyphase wattmeters. All are self contained. The voltmeters and potential circuits for the wattmeters are triple rated 110/220/550 volts and the ammeters and current circuits of the wattmeters are rated up to 20 amperes.

General News Section

The Electric Service Supplies Company, Phildelphia, Pa., has removed its Chicago office from the Monadnock Building to the Illinois Merchants Bank building, 230 S. Clark street.

The Public Service Commission of New York has approved the petition of the Erie Railroad Company to operate an oil electric locomotive within its 28th Street yard in New York City.

W. F. James has been appointed manager of the Philadelphia district of the Westinghouse Electric and Manufacturing Company, succeeding H. H. Seabrook, who has been assigned to special duties.

The Western Electric Company recently announced the appointment of E. P. McGrath as sales manager of its Brooklyn supply house. Mr. McGrath succeeds W. D. Koch, who was transferred to the sales department of the Western Electric Boston supply house.

"Comparative Merits of Steam and Electricity in Railroad Operation" was the title of a paper presented before the New England Railroad Club at Boston on December 8 by L. K. Sillcox, general superintendent of motive power of the Chicago, Milwaukee & St. Paul.

W. E. Brown has been appointed district manager of the central station department, New York District, of the General Electric Company, with offices at 120 Broadway, New York. Mr. Brown was manager of the Schenectady local office of the New York district.

The Interstate Commerce Commission has suspended until further order the effective date of its second train control order (January 14, 1924) in so far as it concerns the Boston & Maine; but has denied that road's petition for a further suspension of the effective date of its first order (June 13, 1922).

The Richmond, Fredericksburg & Potomac has ordered the Union Switch & Signal Company, following the governmental inspection of its 20 mile experimental section, to proceed with the installation of the Union continuous inductive automatic train control apparatus on its entire line from Richmond, Va., to Washington, D. C., a total of about 100 miles, double track.

The Kuhlman Electric Company, Bay City, Michigan, has awarded a contract to the Henry G. Webber Construction Company for an addition to the Kuhlman factory. This addition will measure approximately 75 x 250 feet. In the new building the Kuhlman Company is preparing to build the larger sizes of Transformers.

At Sunbury, Pa., on the evening of November 16, a robber, not masked, intimidated the ticket agent of the Pennsylvania Railroad in his office and took $410. The robbery was committed while a large number of passengers were near. A few minutes before this the ticket agent of the Reading Company, a short distance away, had been threatened, apparently by the same man, but without loss, the robber disdaining the small sum ($15) which the agent had exposed.

The Public Service Commission of New York has approved the use by the Long Island Railroad Company of a 100-ton oil electric type locomotive for freight purposes only within New York City. The company plans to use the locomotive between various yards at Long Island City and Holban Yard, Manhattan Beach, Bay Ridge, together with Evergreen and Bushwick branches, and for emergency operation elsewhere.

H. A. Watkins has recently been appointed Metropolitan district sales manager for the Bridgeport Brass Company, with offices in the Pershing Square Building, New York City. Mr. Watkins comes to this appointment with a wide experience in general industrial and utility development work. He is better known perhaps for his work as superintendent of docks under the Mitchell administration and as a major of engineers during the late war.

Argentine Railway Electrification

Formal application has been made to the Argentine federal government for permission to electrify the tracks of the Central Argentine Railway from Retiro (Buenos Aires) to Villa Ballester and Tigre, via Coghlan, according to Modern Transport (London). The line, which runs northwest for about 25 miles, carries considerable traffic between the capital and a number of small towns, some of which, although but recently established, are rapidly extending their industries.

Westinghouse Company Promotes Executives

Edward D. Kilburn, vice-president and general manager of the Westinghouse Electric International Company, and Walter S. Rugg, general sales manager of the Westinghouse Electric and Manufacturing Company, were named vice-presidents of the latter company at a recent meeting of the board of directors in New York. At the same time Richard B. Mellon of Pittsburgh, was elected a director of the company. Mr. Mellon will fill the vacancy caused by the death of William McConway, formerly president of the McConway & Torley Co.

Dean K. Chadbourne was appointed general manager, to succeed E. D. Kilburn.

Vice-president H. D. Shute, aside from the direct operation of the sales department which will be handled by Mr. Kilburn, will retain his direction of the broad commercial activities of the company, including especially customer relationships.

Vice-president H. P. Davis, formerly in charge of

engineering and manufacturing activities as applying to the strictly electrical portions of the company's business, will have direction over the entire manufacturing activities of the company and, in addition, will have direction of the general features of the radio business, including broadcasting.

Austrian Railway Electrification

In addition to the electrification of the Innsbrueck-Bludenz section of the railway line from Arlberg, which was opened four months ago, the Austrian Federal Railway Board has recently electrified the Stanach-Inning and the Attnang-Puchheim lines, the total length of which is 151 miles, according to Modern Transport (London). The necessary power is supplied by a station on the Spullersee. The economy in coal resulting from the electrification of these two lines will amount to about 130,000 tons a year. The electrification of the Salzburg-Woergl-Innsbrueck-Brenner, Kufstein-Woergl and Simmering-Gloggnitz-Murz lines will be begun in the near future.

Great Northern Completes Electrification Plan

The Great Northern has completed tentative plans for a $10,000,000 water power development in the vicinity of Lake Chelan in north central Washington. The proposed facilities will provide for the development of 75,000 hp. to be used in the projected electrification of the Great Northern's line over the Cascade mountains and will also enable 80,000 acres of land in the vicinity to be irrigated. In connection with its electrification plan, the Great Northern contemplates the construction of an 8½-mile tunnel through the Cascade mountains to replace the present shorter tunnel and snow sheds.

Through a subsidiary, the Chelan Electric Company, the Great Northern has executed a contract with the Washington Water Power Company for the construction and operation of a dam and power plant at Lake Chelan. It is intended that the power generated at this plant shall be used eventually in the operation of trains over the Cascade mountains, but it is recognized that this project will require years for completion.

The proposed new tunnel through the Cascades which will be 8½ miles long, will replace 17 miles of the present line. The maximum grade will be considerably reduced and a number of snow sheds eliminated. The present plans for the tunnel call for an eastern entrance at Berne, Wash., and a western entrance near Scenic.

Steam Roads to Be Taken Over by Electric Line

The Holyoke (Mass.) Street Railway Company announces that it is making arrangements to take over the operation of the Easthampton branch of the Boston & Maine, about three miles long, and the Williamsburg branch of the New York, New Haven & Hartford, six miles in length. On both of these branches passenger train service has long since been discontinued because of the falling off in traffic. The street railway company proposes to transport freight as well as passengers. These plans, if carried out, will involve the discontinuance of trolley car service on the highways which are roughly parallel to the railroad lines. Both of these street lines are crooked and operation is subject to difficulties because of numerous crossings. From Holyoke, northward to the junction with the Easthampton branch, the street railway has a line parallel to the Boston & Maine and it is proposed to run cars through between Holyoke and Easthampton.

Personals

Lowell C. Noyes has recently been appointed district sales manager in charge of the Chicago territory for the Chicago Fuse Manufacturing Company, at Chicago, Ill. He will have his office at the company's general offices and factory at 15th & Laflin Streets, Chicago. Mr. Noyes was graduated from Sheffield Scientific School of Yale University in 1915, and after serving in the army, was with the Union Drop Forge Company, Chicago, for three years, leaving that company to join the engineering department of the Chicago Fuse Company. In 1914 he was transferred to the sales department as sales manager, in which capacity he has been engaged until his recent promotion.

Lowell C. Noyes

Clinton L. Bardo, formerly general manager of the New York, New Haven & Hartford, who resigned in June, 1925, has been elected a vice-president of American Brown, Boveri Electric Corporation, with headquarters at 165 Broadway, New York City, a subsidiary of Brown, Boveri & Co., Ltd., Baden, Switzerland, electrical manufacturers, who early this year announced that they would enter the American market. The new company has bought the plant of the New York Shipbuilding Corporation at Camden, N. J., and will make this its manufacturing center for the building of turbines, electric locomotives and large electrical apparatus. In addition, the company has manufacturing facilities at Hyde Park, Boston, Mass., and at Sidney, N. Y. Mr. Bardo, who will have his headquarters at New York, has left for a six weeks' tour abroad to inspect the plants of the associated companies. Clinton L. Bardo was born on October 24, 1867, and began railway work as a telegraph operator on the Philadelphia & Erie division of the Pennsylvania Railroad in

C. L. Bardo

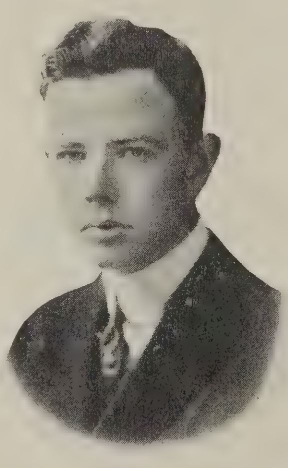
May, 1885. He was in the service of the Pennsylvania for about a year and then for a brief period served with the Philadelphia & Reading, now the Reading Company, and the Tidewater Oil Company. In October, 1887, he went to the Lehigh Valley as telegraph operator and shortly after was promoted to train dispatcher. In 1892, he served as assistant trainmaster, then trainmaster, and in 1901, was promoted to trainmaster on the New York division. Mr. Bardo, in October, 1904, went to the New York, New Haven & Hartford as freight trainmaster at Harlem River, N. Y., becoming asistant superintendent of the division in 1905. In 1907 he was appointed superintendent of the Grand Central Terminal, New York City, and superintendent of the electric division of the New York Central, resigning from that position in 1911 to return to the Lehigh Valley as assistant to the general manager. In February, 1913, he resigned from the Lehigh Valley and was appointed general manager of the New York, New Haven & Hartford, and in September, 1917, he was appointed assistant to the president, also remaining in general charge of the operating department, with headquarters at New Haven, Conn. Mr. Bardo resigned from the New Haven service in June, 1925.

V. R. Emrick has been appointed chief electrician, Florida East Coast Railway Company, succeeding C. J. Zeigler, resigned.

Chris J. Zeigler resigned from the position of chief electrician, Florida East Coast Railway Company, on November 1, of this year to join the "Land Merchants" of Florida, organizing the Palmera Properties Company, Inc., of which he is president, with office at 205 Lew Building, St. Augustine, Florida. Mr. Zeigler has been in continuous service with the railway company for the past 15 years.

Obituary

George Young Allen, whose death was noted in the November issue of the *Railway Electrical Engineer,* was one of the rising figures of the radio industry. As technical assistant to the manager of the radio department of the Westinghouse Electric and Manufacturing Company he was directly concerned with many of the technical developments and commercial applications of radio, particularly carrier current.



G. Y. Allen

Mr. Allen was born in Bernardsville, N. J., in 1893, and graduated from Stevens Institute of Technology, Hoboken, in 1915, with a degree of M.E. He was engaged in research work for the Western Electric Company after graduation and at the outbreak of the war was made radio aide to the U. S. Navy Engineering Bureau. He entered the radio department of the Westinghouse Company in 1919.

Mr. Allen was a member of the Institute of Radio Engineers, the American Institute of Electrical Engineers, the National Electric Light Association, and the Associated Manufacturers of Electrical Supplies.

When he met his death, he was returning from the Fourth Annual Radio Conference called at Washington by Secretary Hoover where he represented the Radio Manufacturing Industry in the design of the technical features of the new radio law to be presented for congressional action by Secretary Hoover.

"Mr. Allen's death means a great loss to the Westinghouse Company" said E. B. Mallory, manager of the Westinghouse Radio Department. Brilliant as an engineer, indefatigable as a worker, and charming personality, it will be impossible to replace him.

Trade Publications

The Ohio Brass Company, Mansfield, Ohio, is distributing an illustrated folder showing and describing the National trolley guard for keeping trolley wheels in contact with the trolley wire when a car is passing over a railroad crossing.

Wild-Barfield Electric Furnaces is the title of a 24-page illustrated bulletin recently published by the Automatic and Electric Furnaces, Ltd., London. The book gives a description of electro-magnetic furnaces used for the automatic hardening of steel.

Crouse-Hinds Company, Syracuse, N. Y., in a large illustrated folder shows the design of Condulets for tumbler switches. In a small illustrated 16-page bulletin the company gives much more detail concerning this line as regards style, capacity and prices.

General Electric Steam Turbines rated at 500, 600 and 750 kw. are described in Bulletin GEA-235, just issued by the General Electric Company, Schenectady, N. Y. The general principles and advantages of steam turbines are discussed, and sections and steam path diagrams are shown.

The Okonite Company, Passaic, N. J., is distributing a new illustrated booklet entitled "Splices and Tapes for Rubber Insulated Wires." The booklet contains 16 pages and the four subjects treated are: Importance of a Perfect Splice; Important Properties of Tape; How to Recognize These Properties and How to Make a Perfect Splice.

Electric Drive for Gasoline Buses is described in bulletin GEA-149, a new publication of the General Electric Company, Schenectady, N. Y. Photographs of buses in operation, schematic diagrams and characteristic curves, descriptions of the electrical equipments, and a summary of advantages and maintenance data are included in the contents.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued folder 4664, describing the operation and electrical equipment of "The 250 Hp. Gasoline-Electric Car for the Reading Company." This folder, in addition to information on performance and electrical equipment, describes the advantages of gasoline-electric equipment, illustrates the engine generator unit, gives floor plan in elevation of the car and gives complete weights, dimensions and ratings.

Power Illumination

Railway Electrical Engineer

Heavy Electric Traction · Train Lighting · Electric Welding

VOLUME 16 DECEMBER, 1925 NUMBER 12

Volume 16 **Number 12**

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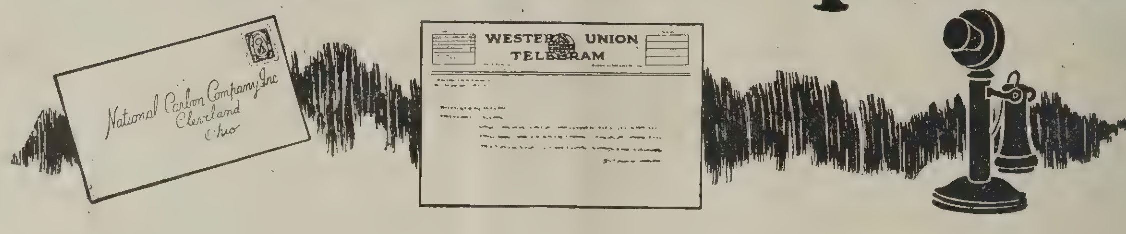
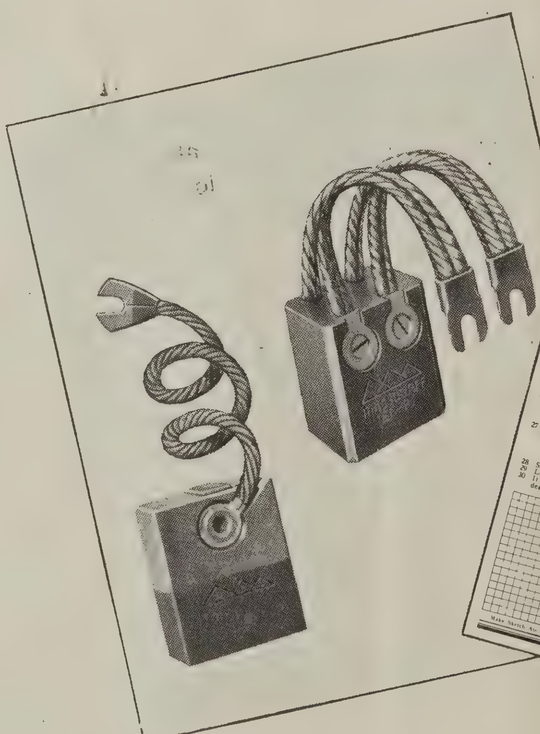
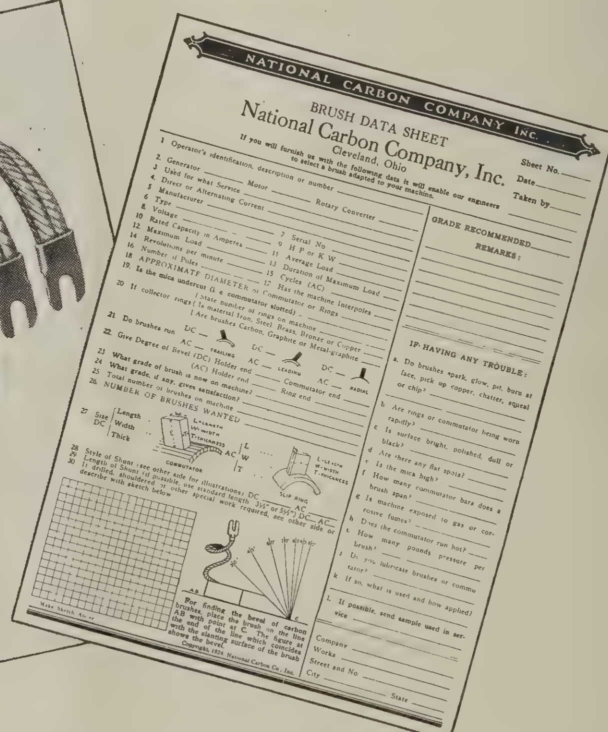
write – wire – phone



WHEN you need brushes on short notice for any reason *write, wire* or *phone* the nearest of our four plants, and the National Pyramid Brushes you need will be on their way to you immediately.

Have we complete data sheets on your motors, generators and converters? Information regarding our data sheet service gladly sent on request.





The services of our Sales Engineers are always at your disposal

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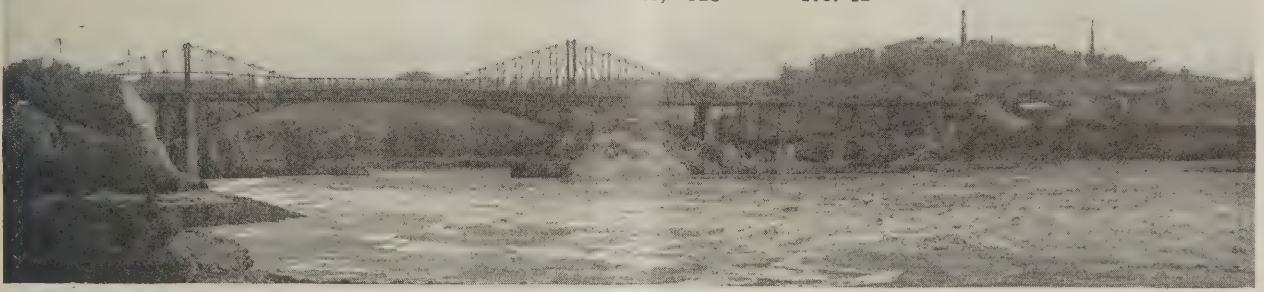
Railway Electrical Engineer

Vol. 16 December, 1925 No. 12



C. P. R. Bridge at Reversing Falls, St. John, N. B.

Contents

Published on the second Thursday of every month by the

Simmons-Boardman Publishing Company, 30 Church Street, New York

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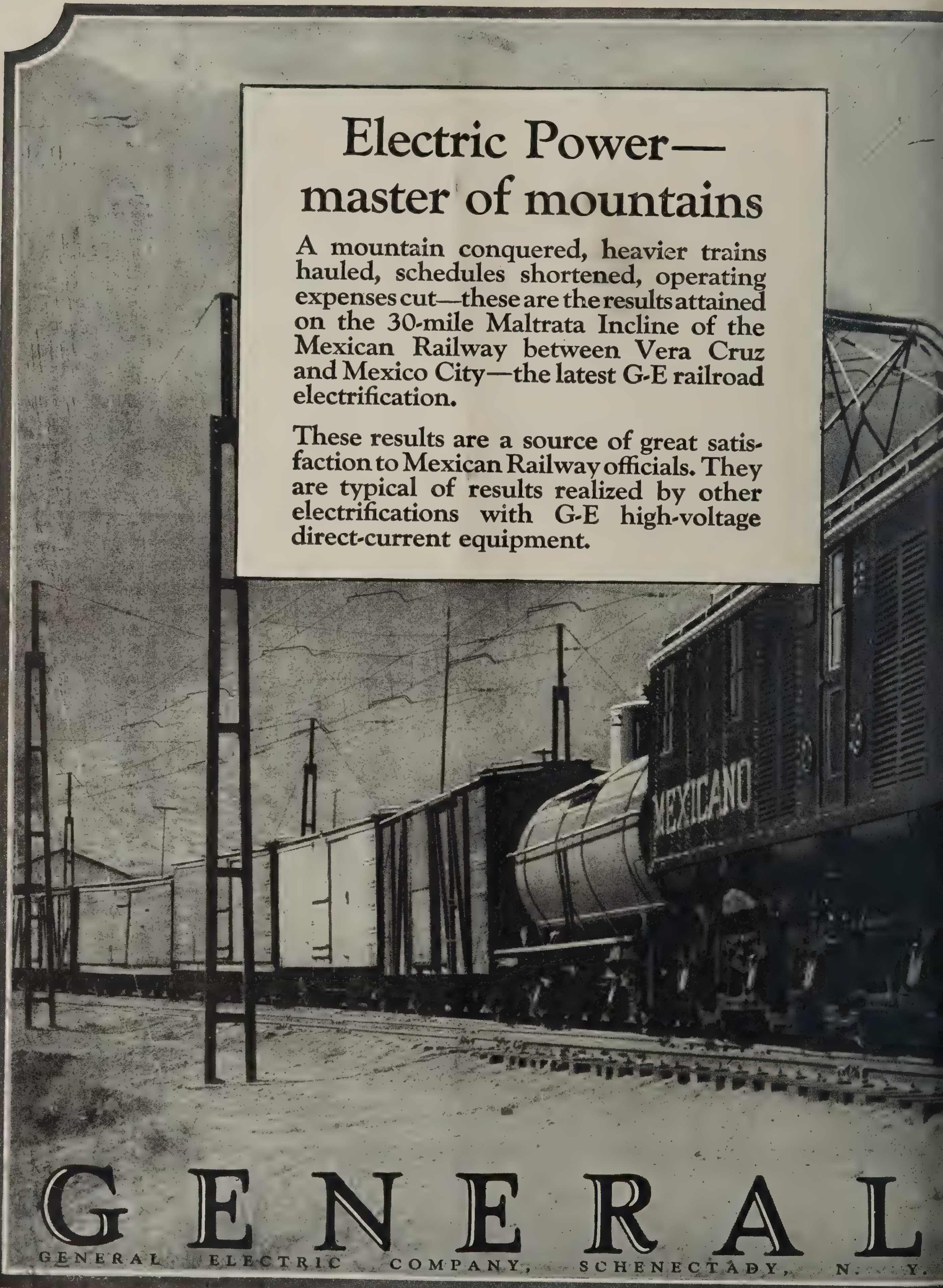
REQUEST for change of address should reach us two weeks before the date of the issue with which it is to go into effect. It is often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your OLD address as well as the NEW one.

The Railway Electrical Engineer is a member of the Associated Business Papers (A. B. P.) and of the Audit Bureau of Circulation (A. B. C.)


Electric Power—
master of mountains
A mountain conquered, heavier trains hauled, schedules shortened, operating expenses cut—these are the results attained on the 30-mile Maltrata Incline of the Mexican Railway between Vera Cruz and Mexico City—the latest G-E railroad electrification.
These results are a source of great satisfaction to Mexican Railway officials. They are typical of results realized by other electrifications with G-E high-voltage direct-current equipment.
MEXICANO
GENERAL
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.


1006
1006
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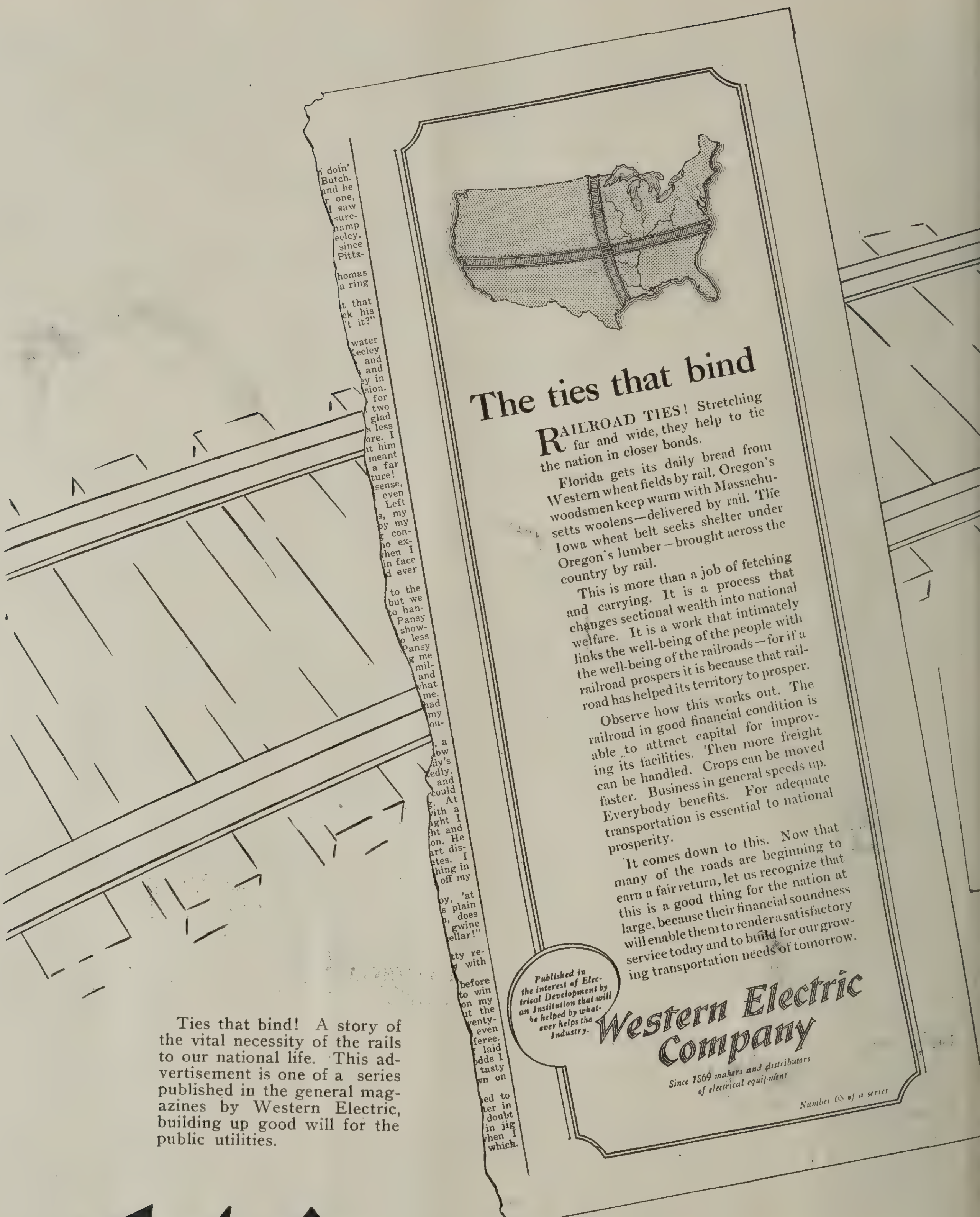
ELECTRIC
SALES OFFICES IN ALL LARGE CITIES



The ties that bind

RAILROAD TIES! Stretching far and wide, they help to tie the nation in closer bonds.

Florida gets its daily bread from Western wheat fields by rail. Oregon's woodsmen keep warm with Massachusetts woolens—delivered by rail. The Iowa wheat belt seeks shelter under Oregon's lumber—brought across the country by rail.

This is more than a job of fetching and carrying. It is a process that changes sectional wealth into national welfare. It is a work that intimately links the well-being of the people with the well-being of the railroads—for if a railroad prospers it is because that railroad has helped its territory to prosper.

Observe how this works out. The railroad in good financial condition is able to attract capital for improving its facilities. Then more freight can be handled. Crops can be moved faster. Business in general speeds up. Everybody benefits. For adequate transportation is essential to national prosperity.

It comes down to this. Now that many of the roads are beginning to earn a fair return, let us recognize that this is a good thing for the nation at large, because their financial soundness will enable them to render a satisfactory service today and to build for our growing transportation needs of tomorrow.

Published in the interest of Electrical Development by an Institution that will be helped by whatever helps the Industry.

Western Electric Company

Since 1869 makers and distributors of electrical equipment

Number 68 of a series

Ties that bind! A story of the vital necessity of the rails to our national life. This advertisement is one of a series published in the general magazines by Western Electric, building up good will for the public utilities.

Western

QUALITY ELECTRICAL

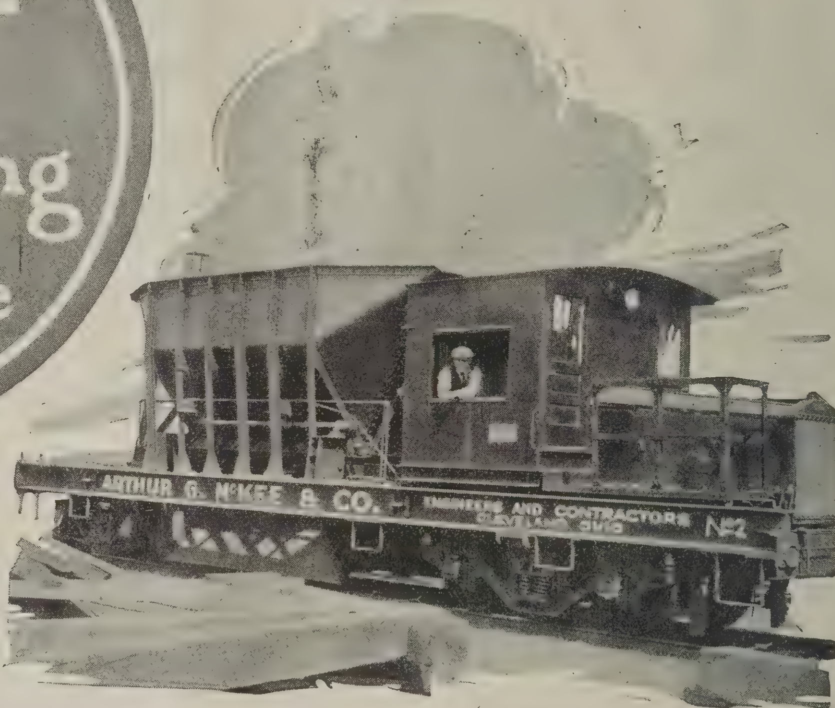
OFFICES IN

"BEST BEARINGS FOUND WHERE WHEELS TURN 'ROUND"

SKF Puts the Right Bearing in the Right Place

SKF is linked with a world-wide reputation for delivering satisfactory service, and to an investment too large to be jeopardized by non-performance of anything with which it is connected.

Therefore SKF provides a supervision of factories throughout the world and an international organization for scientific research in engineering, manufacturing and merchandising to assure to the user a full measure of performance in products endorsed with the mark SKF.



Gasoline Locomotives Meet All Traffic Demands When SKF-Equipped

ALL set to go! The operator knows that the SKF-marked Ball and Roller Bearings on the vital rotating parts of this gasoline locomotive possess the ruggedness and precision which insures smooth operation without trouble or constant attention under the heaviest demands.

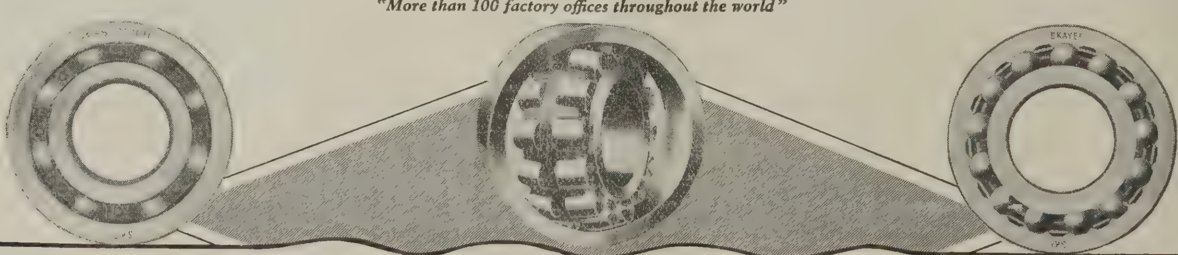
In the most unusual places, where reliability and consistent performance over a period of years are the deciding factors in the choice of bearings, SKF-marked Ball and Roller Bearings have been widely adopted the world over on many varied types of commercial and railway equipment.

SKF INDUSTRIES, INCORPORATED — 165 BROADWAY — NEW YORK CITY

ATLANTA, BOSTON, BUFFALO, CHARLOTTE, CHICAGO, CINCINNATI, CLEVELAND, DALLAS, DETROIT, EL PASO, HARTFORD, INDIANAPOLIS, LOS ANGELES, PHILADELPHIA, SAN FRANCISCO

"More than 100 factory offices throughout the world"

1470



BALL AND ROLLER BEARINGS

UNION

NEW AND IMPROVED RENEWABLE FUSES

Take One Apart Yourself—

and then the extreme simplicity will be apparent

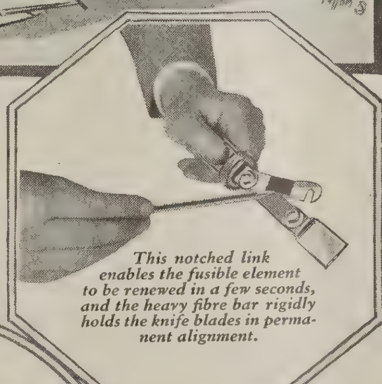
Have you had an opportunity of examining the new and improved Union Renewable Fuse—of taking it apart, of noting the simple design and rugged construction, and of seeing how easily it is assembled?

Then—and only then—can you appreciate how Union Renewable Fuses will succeed in minimizing the cost of fuse maintenance wherever they are used. They stay in service indefinitely because the substantial construction guarantees an exceptionally large number of blowouts, and because simple design results in few parts, making easy renewal and assembly. They are fully approved by the Underwriters, and are made in all standard ratings, 65 to 600 amperes, 250 and 600 volts.

Hundreds of fuse users, jobbers and dealers have seen the new Union Fuse and given it their unqualified approval. Electrical supply houses have stocked up to take care of the great demand that has been created since the first announcement of this improved fuse.

Send in an order for your requirements and when you see one of these fuses you'll be convinced that your maintenance costs will be materially reduced.

Few parts—quality materials and highest grade workmanship—backed by a quarter century of fuse specialization.



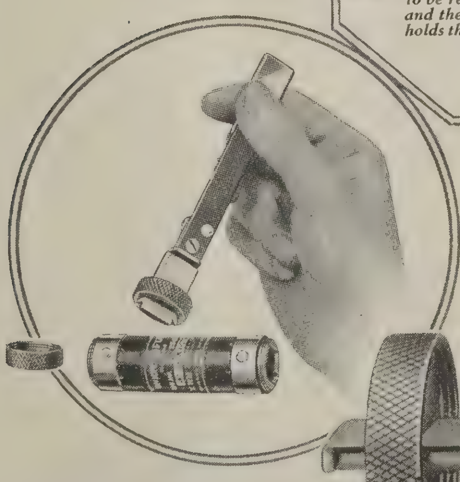
This notched link enables the fusible element to be renewed in a few seconds, and the heavy fibre bar rigidly holds the knife blades in permanent alignment.

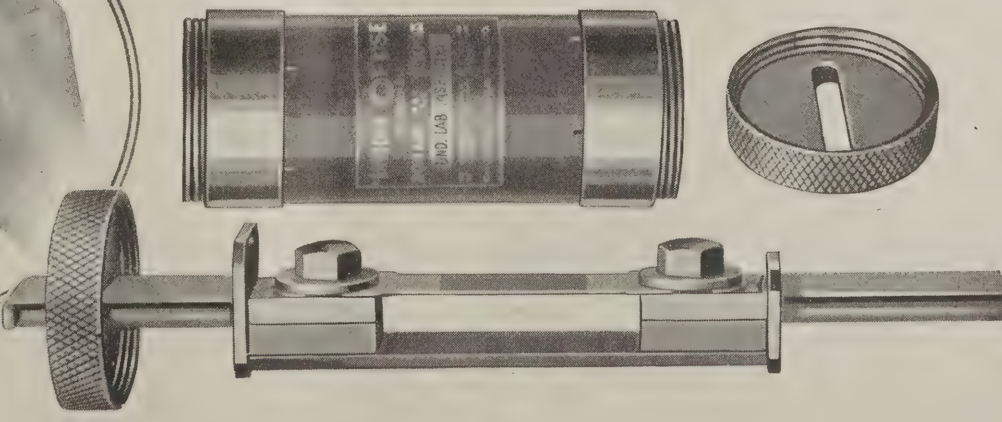
CHICAGO FUSE MFG. CO.

MANUFACTURERS OF

ELECTRICAL PROTECTING MATERIALS AND CONDUIT FITTINGS

1525 West 15th Street
CHICAGO, ILL.





One cap can be removed entirely—the other is held on the knife blade by two nibs.

ANNOUNCING

a New Product

The Kulp Theft Proof Lamp is distinctly a new idea in the lamp field. The possibilities of its service to railroads particularly, are so apparent that we are glad to announce its advent into the Lundy family of merit-proven products.

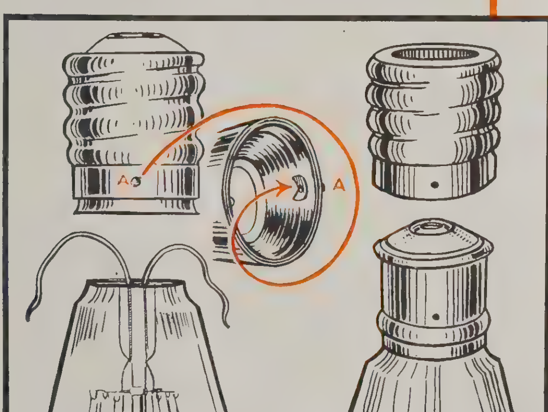
Figures submitted by the roads themselves show an annual loss from the theft of lamps in shops, stations, freight houses, office buildings, round houses, etc., varying anywhere from 15% to 30% of their lamp purchases. One large system writes off $13,000 a year in this way. A smaller line admits to $3,000 loss in ten months. These are certainly suggestive figures, rendered all the more important since every dollar of the entire amount can be saved.

The Kulp Lamp is a *standard* lamp, exactly the same as you now use—with the big difference that it positively *cannot be removed from the socket.* It will go in your present sockets without changes or without extra attachments. The patented theft-proof feature is built into the lamp at the factory—a unique principle exclusive with the Kulp Lamp.

Most important—*you need not pay a cent more* for these theft-proof lamps than you now pay for ordinary lamps. Prices and discounts are absolutely standard—standard lamps backed by standard guarantees. Note also, the special "2 in 1" feature—theft-proof or regular as you desire.

The lamp that cannot be stolen.

STANDARD
Lamps
Guarantee
Prices



2 in 1

This special feature makes it possible to use the Kulp Lamp either as a theft-proof bulb or as a regular bulb. An extra twist in the socket does the trick.

The principle is simple. The threaded shell is held rigidly to the base by a small pin and washer (A). The lamp is inserted in the socket as usual until contact is made. If the extra twist is given, this pin is sheared off, allowing the lamp and base to turn freely, while the shell remains in the socket. To remove, the bulb is broken, after which the shell may easily be reached and unscrewed. Since the lamp can only be removed by breaking, all incentive to theft is gone.

Your best test of the Kulp Lamp is a case tried out in your most exposed sockets. If you wish, we will be glad to send a sample lamp for your examination, if you will specify voltage.

RAILWAY SALES AND SERVICE BY

F. A. Lundy Company

A NATIONAL SALES & ENGINEERING SERVICE for RAILWAYS

FULTON BUILDING	HARRISON BUILDING	MARQUETTE BUILDING
PITTSBURGH, PA.	PHILADELPHIA, PA.	CHICAGO, ILL.

STANDARD PRICES AND DISCOUNTS — KULP THEFT PROOF LAMP

"B" VACUUM LAMPS

Kulp Theft Proof

110, 115, 120, 125 Volts

Size or Watt	Approximate Lumens	Bulb	Diam. bulb, in.	Length bulb, in.	Stand. Pkg. Quan.	List Price Clear	List Price Frosted
10	78	S-14	4¼	1¾	120		
15	130						
25	240	S-17	2⅛	4⅞		$0.27	$0.32
40	400				120		
50	500	S-19	2⅜	5⅜			
60	620	S-21	2⅝	5½	120	.32	.37

"B" LAMPS FOR LIGHTING MILL AND FACTORY

Kulp Theft Proof

220, 230, 240, 250 Volts

Size or Watt	Approximate Lumens	Bulb	Diam. Bulb, in.	Length Bulb, in.	Stand. Pkg. Quan.	List Price Clear	List Price Frosted
Furnished in Medium Screw Base							
25	190	S-19	2⅜	5⅜	120	$0.32	$0.37
50	450						

DECORATIVE "B" LAMPS

Kulp Theft Proof

Round Tungsten—110, 115, 120, 125 Volts

15	126	G-18½	2$\frac{5}{16}$	3¾	120	$0.40	$0.40
25	225	G-18½	2$\frac{5}{16}$	3¾	120	.40	.40
25	242	G-25	3⅛	4¾	60	.50	.50
40	400	G-25	3⅛	4¾	60	.50	.50

110, 115, 120, 125 Volts Tubular

25	240	T-10	1¼	5⅞	100	$0.45	$0.50

For Farm and Country Home Lighting
30 to 34 Volts

10	94	S-14	1¾	4¼	120		
15	155	S-17	2⅛	4⅞	120	$0.27	$0.32
25	260						
40	340	S-19	2⅜	5⅜	120		
50	440	S-19	3⅜	5⅜	120	.27	.32

"B" CLEAR MILLITE

Kulp Theft Proof

110, 115, 120, 125 Volts

"B" for Mills, Factories, Mines, etc.

Watts	Approx. Lumens	Bulb	Maximum Over All Length, in.	Stand. Pkg. Quan.	List Price Clear	List Price Fros	List Price Blue
25	200	P-19	4	120	$0.30	$0.35	$0.45
50	420				.30	.35	.45
60	520	P-21		120	.45	.50	.55

INSIDE FROSTED LAMP

25	A-19	Med.	120	I	$0.30

"B" LAMPS FOR LIGHTING MILL AND FACTORY

Kulp Theft Proof

220, 230, 240, 250 Volts

Size or Watt	Approximate Lumens	Bulb	Diam. Bulb, in.	Length Bulb, in.	Stan. Pkg. Quan.	List Price Clear	List Price Fros
Mill Type "B" for Mills, Factories, etc.							
50	370	P-19		4	120	$0.32	$0.37

DISCOUNT SCHEDULE

Net Value Exclusive of Freight Charges	Standard Packages Quantities	Broken Package Quantities
Less than $75	10%	0%
75	15%	5%
150	18%	8%
300	21%	11%
600	24%	14%
1,200	27%	17%
2,500	29%	19%
$5,000	31%	21%
10,000	33%	23%
20,000	34%	24%
$30,000	35%	25%
50,000	36%	26%
100,000	37%	27%
$150,000	38%	28%
225,000	39%	29%
300,000	40%	30%

To Purchasers Without Contract

Standard Case	10%	0%

STANDARD GAS FILLED

"C" Lamps

Kulp Theft Proof

For Store Lighting and Large Areas

110, 115, 120, 125 Volts

Size or Watt	Approximate Lumens	Bulb	Diam. Bulb, in.	Length Bulb, in.	Stand. Pkg. Quan.	List Price Clear	List Price Fros	List Price Blue
50	500	PS-20	2¾	6⅛	60	$0.40	$0.45	$0.60
75	880	PS-22	2¾	6⅛	60	.45	.50	.65
100	1300	PS-25	3⅛	7⅛	24	.50	.55	.80
150	2100	PS-25	3⅛	7⅛	24	.65	.70	1.05
200	3100	PS-30	3¾	8⅜	24	.80	.85	1.30

"C" Lamps for Lighting Large Areas

Kulp Theft Proof

220, 230, 240, 250 Volts

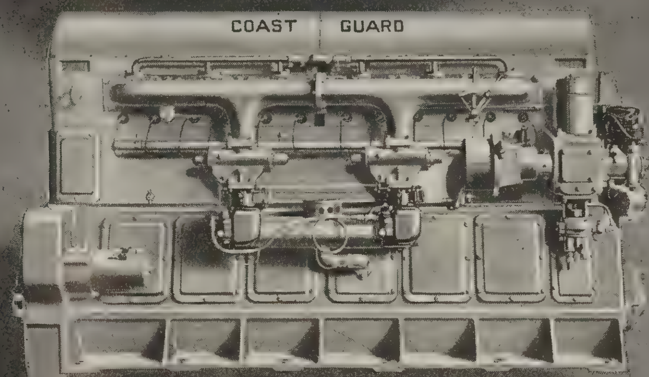
100	1000	PS-25	3⅛	7⅛	24	$0.60	$0.65
200	2600	PS-30	3¾	8⅜	24	1.00	1.10

Type "C-4" Milk White

50 Watts	PS-20	110 to 125 Volts	$0.45

"C" LAMPS FOR FARM AND COUNTRY HOME LIGHTING

25	300	PS-20	2¼	5½	60	$0.40	$0.45
50	740	PS-20	2¼	5½	60	.40	.45
75	1200	PS-20	2¾	6⅛	60	.50	.55
100	1700	PS-25	3⅛	7⅛	24	.60	.65

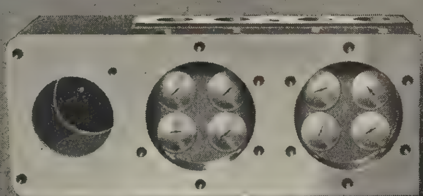


REMOVABLE CYLINDER SLEEVE

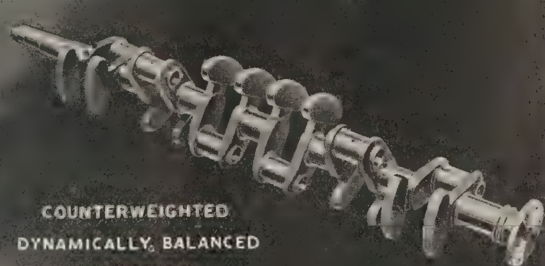
WE repeat this advertisement to emphasize that the "working limits" or tolerances in Sterling Engines, require the machining of each part to almost infinitesimal accuracy. Depending upon its function, every part is machined or ground to within .002 of an inch, many within .0005 of an inch, meaning that the original assembly will operate properly for years, until natural wear necessitates replacement and then, with the aid only of small wrenches, a new part may be installed.

Considering the many features Sterling introduced, actually created, to assure high duty service, prolonged life, and to facilitate servicing the engine, it can be readily seen that the operating cost of motor coaches with Sterling engines should hold at a minimum.

A few more dollars spent initially in a Sterling engine will return substantial dividends.

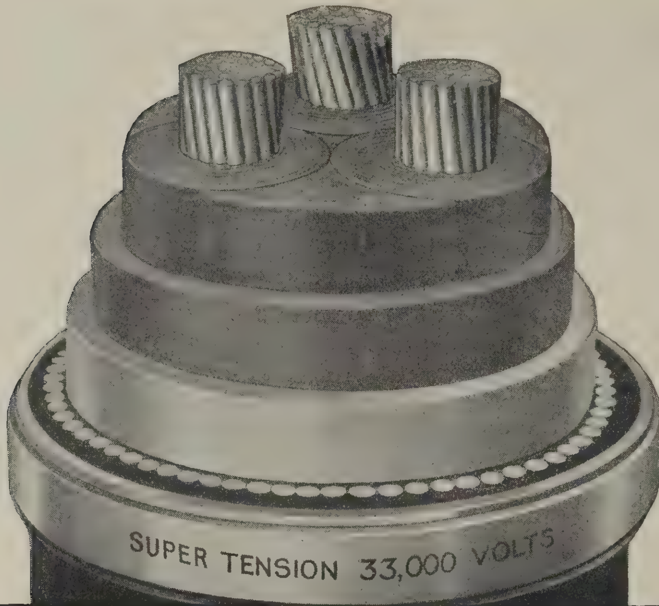


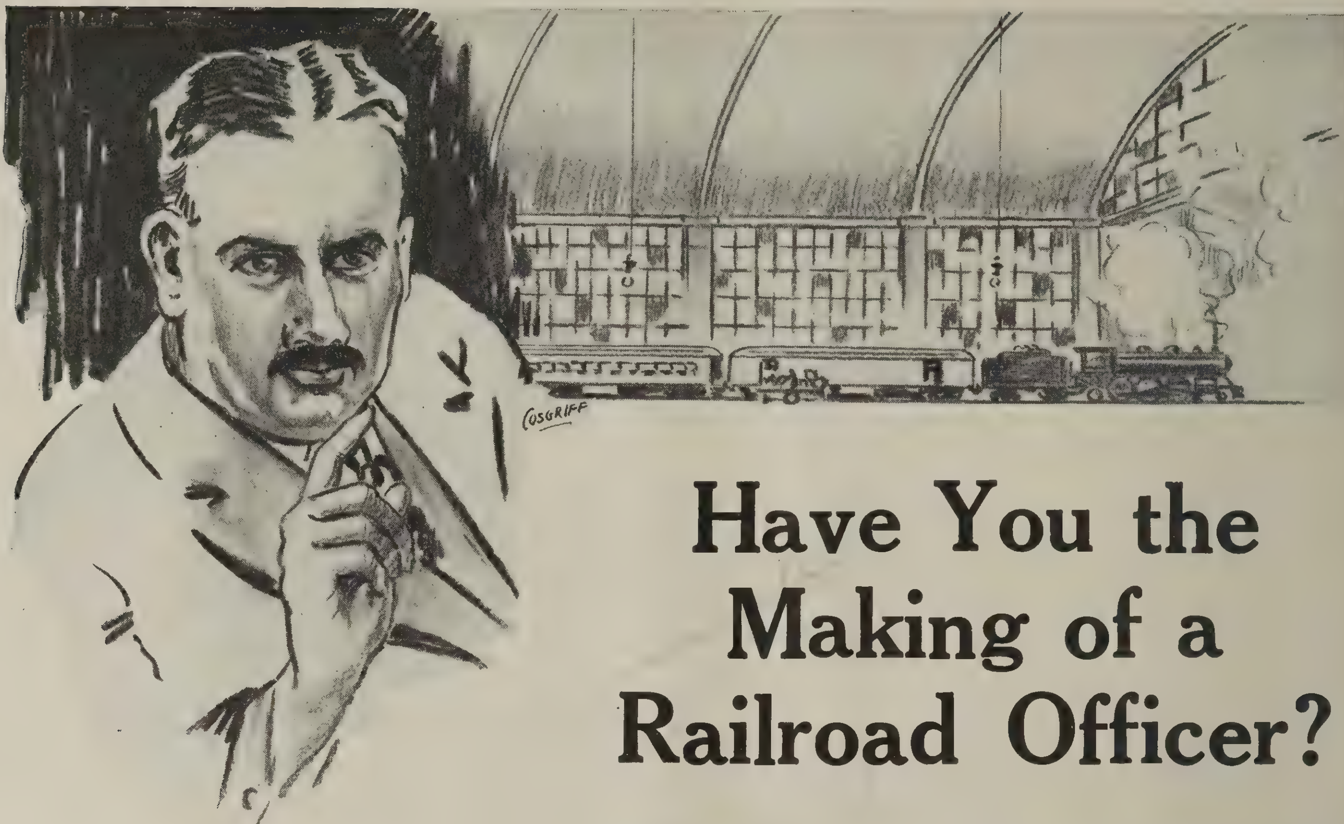
DUAL VALVES IN THE HEAD



COUNTERWEIGHTED DYNAMICALLY BALANCED CRANKSHAFT

STERLING ENGINE CO.
Dept. T-2 Buffalo, N. Y.


SUPER TENSION 33,000 VOLTS



Have You the Making of a Railroad Officer?

A NEW book which will appeal to every railroad man to whom the human nature side of railroading is interesting and worthy of study. "The Making of a Railroad Officer" takes up the subject of railroading from a new angle—that of personal efficiency and of cooperation. It does not confine discussion to any department, rather it will prove helpful and instructive to any officer or employee in any department.

If you have ever stopped to analyze your personal attributes and characteristics pro and con without arriving at any satisfactory conclusion read "The Making of a Railroad Officer." If you desire to know how your characteristics may be made to pay the highest dividends—Read "The Making of a Railroad Officer."

Far from being a dry treatise—this book reads with the tense interest of a novel; its gripping contents will appeal to anyone who is progressive and who is interested in his duties as a railroad man. It's a book you'll want for its instructive, helpful information—one you'll enjoy and read from cover to cover because it is so thoroughly inviting and inspiring.

Order your copy today. You will never regret this investment. The subject this book covers will be as vitally important twenty years from now as today. Just mail the coupon together with $2, and the book will be mailed promptly. Do it today.

Contents of this New Book

"The Making of a Railroad Officer" discusses clearly, in the railroad man's language, the following subjects: Service—Cooperation—Study of Human Nature—Study of Faces or Profiles—Study of Heads—Study of Body Build or Structure—Study of Fineness and Size—Study of Firmness—Differences Between Men and Women—Expression or General Appearance—Employment—Psychology and Memory—Job Analysis—Planning the Work—Organizing the Work—Treatment of Men—Cost Studies—Charting Statistics—Elimination of Emergencies—Safety—Public Speaking—Further Application of Salesmanship Principles—Ethics of Railroading—Staff Teamwork—Personal Application.

SEND THIS COUPON TODAY

Simmons-Boardman Publishing Company,
Book Department,
30 Church Street, New York, N. Y.

Please send me postpaid a copy of "The Making of a Railroad Officer." I enclose herewith $2.00 in full payment.

Name ....

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City .... State ....

Position .... Road ....

E-12-25

245 pages, illustrated, 5 x 7¾ inches, price $2.00

Simmons-Boardman Publishing Company

Book Department

34 Victoria Street
London, S. W. 1

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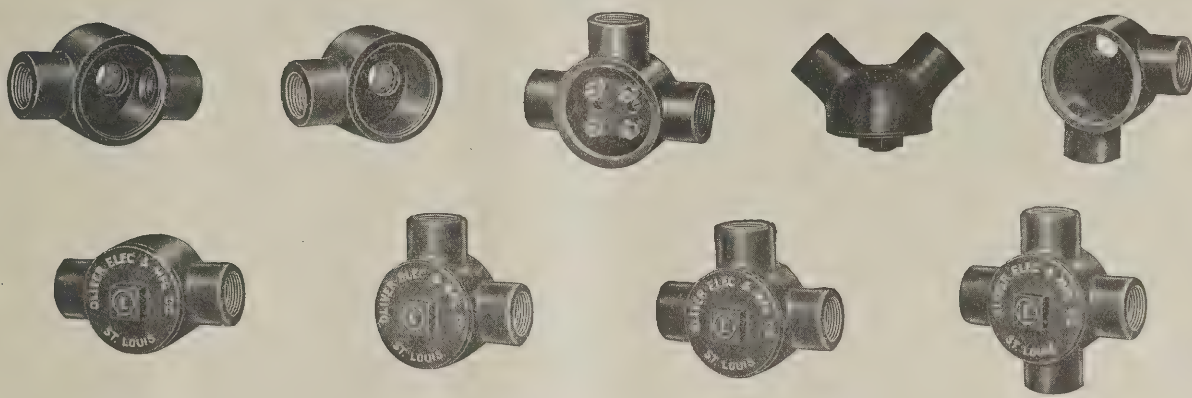
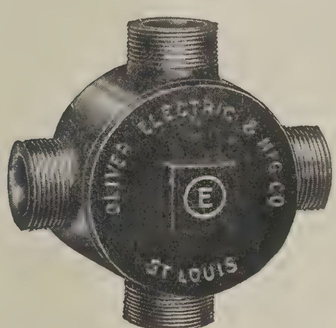
New York, N. Y.

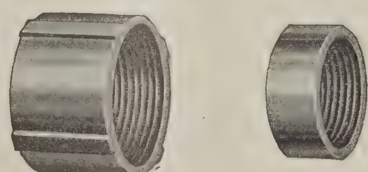
FITTINGS DESIGNED FOR USE IN EQUIPPING LOCOMOTIVES WITH AUTOMATIC TRAIN CONTROL

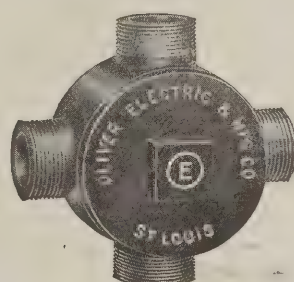
SCREW COVER CONDUIT FITTINGS



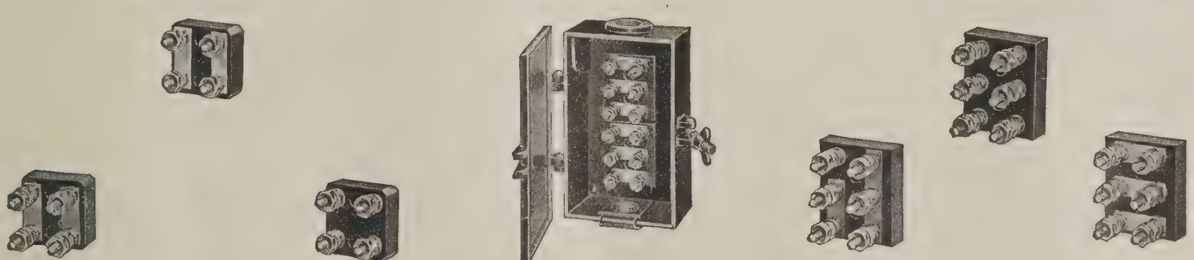
DISCONNECTING JUNCTION AND TERMINAL BOXES







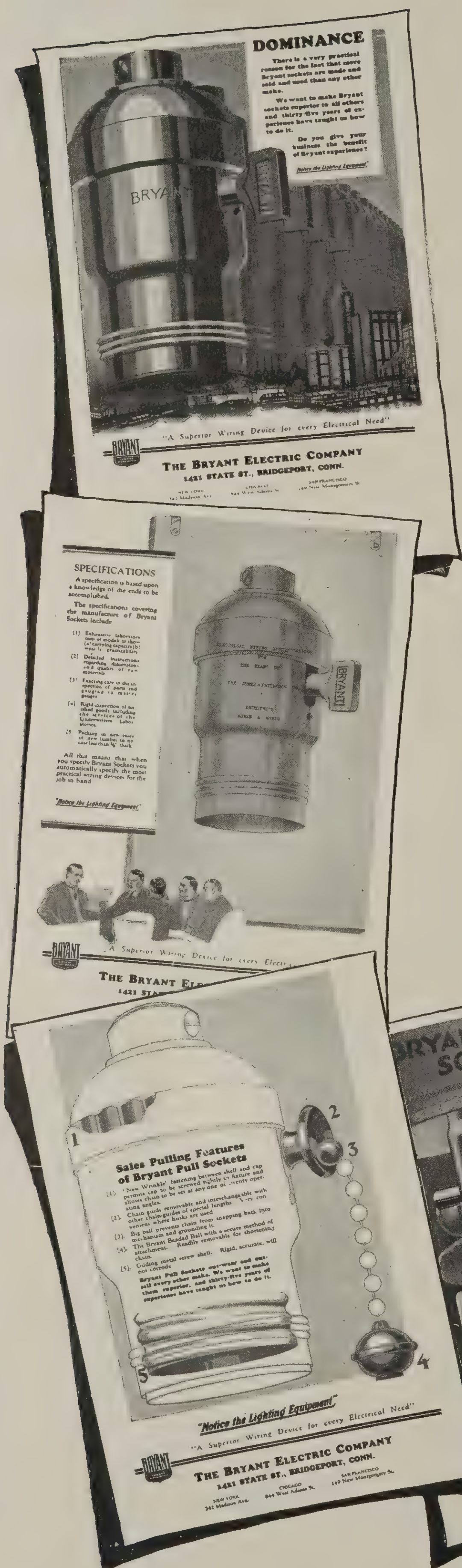
TERMINAL BOXES
TERMINAL BLOCKS



TRAIN CONTROL SWITCHES

OLIVER ELECTRIC & MANUFACTURING COMPANY
SAINT LOUIS, U. S. A.

See our exhibit at Booths 42 and 43 at the A. R. E. E. Convention.

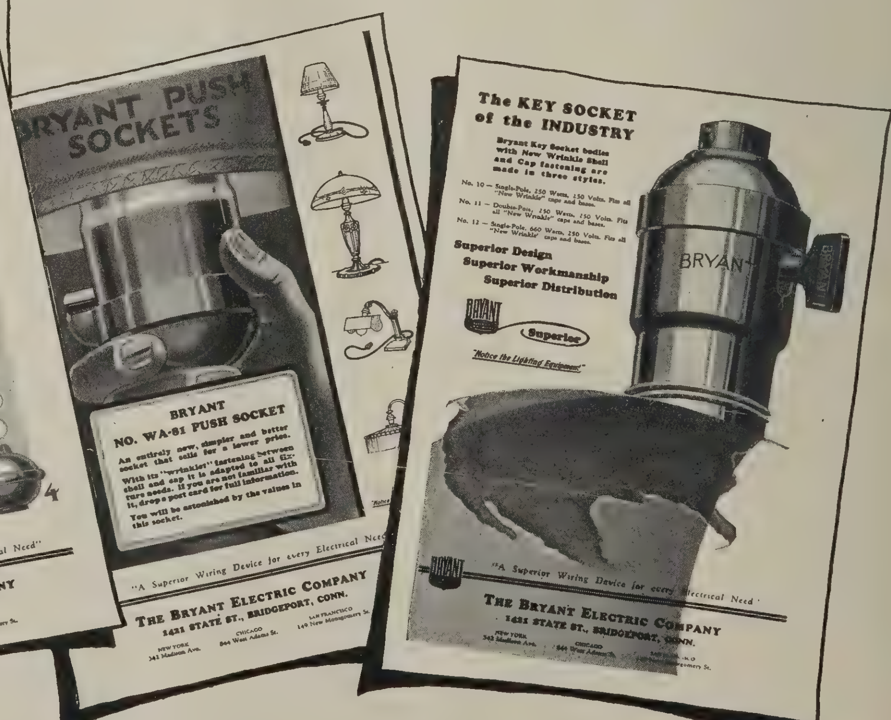


In the face of the modern tendency to hurry, to make things cheaply and merely good enough to pass inspection, Bryant sockets are still made a little better than they need to be. This careful attention to the refinements of design and manufacture has contributed to their reputation for superior quality and made them recognized examples of the adage that the best is most economical in the end.

THE BRYANT ELECTRIC COMPANY

Bridgeport, Connecticut

New York **Chicago** **San Francisco**



Double cotton covered rectangular magnet wire

FA PANELBOARDS ARE STANDARD EQUIPMENT

WHERE DOLLARS ARE SPENT WISELY

FA Panelboards are of standardized unit construction. Every part is made oversize, accurate and true. Complete assemblage is done in our own factories—where the work can be done cheapest. The job is entirely complete when delivered, and shipments can be made on remarkable short notice. The standardized FA Steel Cabinets can be installed months—even years—before the panelboards. Yet the fit will be one of precisioned accuracy.

FA Panelboards are used by practically every big Railroad in the country. What other panelboard has achieved such recognition?

It is not by mere chance that leading Railway Electrical Engineers specify FA Panelboards. And neither is it a coincidence. It is just good sound reasoning in terms of service and dollars and cents.

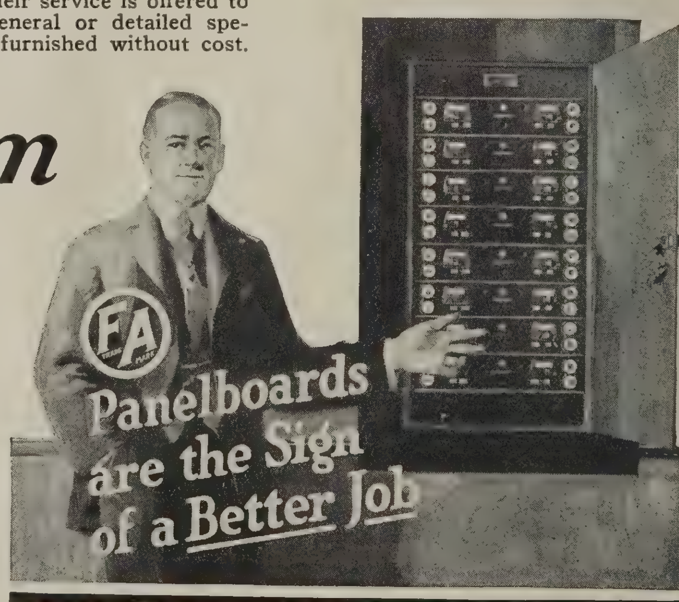
The quality of FA Standardized Sectional Panelboards is judged by the service they render, by their ability to withstand years of use and by the great saving they afford. It has taken six years of tireless effort to build a panelboard of such merit. When you buy Panelboards you may do so with the sound assurance of *being right!* For others have proven it so!

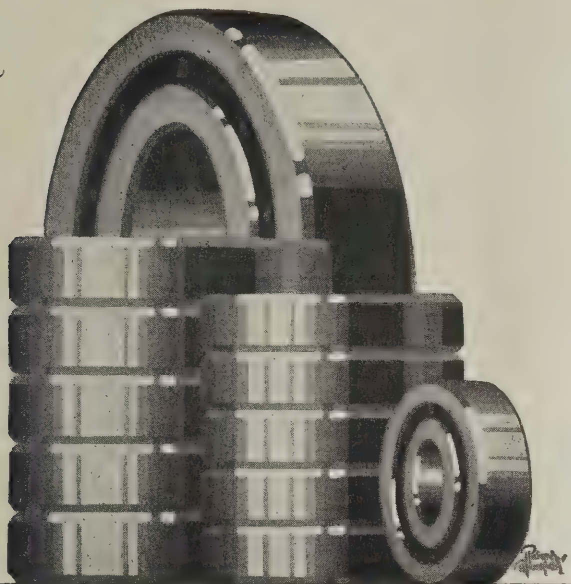
Our engineers have long been of aid to others. Their service is offered to you—with no obligations involved. Write for general or detailed special information, catalogs and estimates. All are furnished without cost.

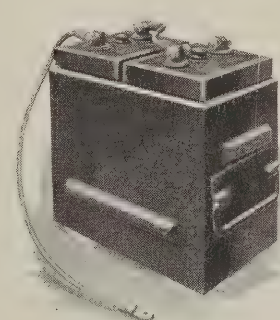
Frank Adam
ELECTRIC COMPANY
ST. LOUIS

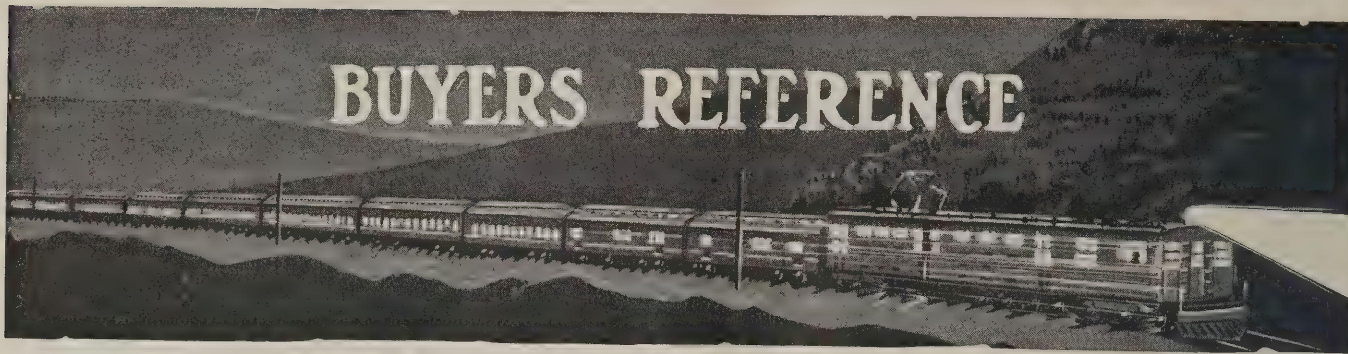
You are always welcome at any of our District Offices:

Atlanta	Minneapolis
Baltimore	New Orleans
Boston	New York City
Chicago	Philadelphia
Cincinnati	Pittsburgh
Dallas	Portland
Denver	Seattle
Detroit	San Francisco
Kansas City	Winnipeg
Los Angeles	London, Ontario









A. C. Floating Battery System
- Westinghouse Electric & Mfg. Co.

Arc Welding Equipment
- General Electric Co.
- Westinghouse Electric & Mfg. Co.

Arresters, Lightning
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Axle Lighting Equipment, Repair Parts
- Electric Storage Battery Co., The

Axle Pulleys
- Electric Storage Battery Co., The
- Safety Car Heating and Lighting Co., The

Axle Pulley Bushings
- Electric Storage Battery Co., The
- Safety Car Heating and Lighting Co., The

Batteries, Dry
- National Carbon Co.
- Western Elec. Co.

Batteries, Lighting
- Electric Storage Battery Co., The
- Willard Storage Battery Co.

Batteries, Radio
- Willard Storage Battery Co.

Batteries, Starting
- Willard Storage Battery Co.

Batteries, Storage
- Electric Storage Battery Co., The
- National Carbon Co.
- Safety Car Heating & Lighting Co., The
- Western Elec. Co.
- Willard Storage Battery Co.

Batteries, Wet Cell
- Electric Storage Battery Co., The
- Safety Car Heating & Lighting Co.
- Willard Storage Battery Co.

Battery Charging Apparatus
- Anderson Mfg. Co., Albert & J. M.
- Central Elec. Co.
- Electric Storage Battery Co., The
- Safety Car Heating & Lighting Co., The
- Western Electric Co.
- Westinghouse Electric & Mfg. Co.

Bearings, Adapter
- Ahlberg Bearing Co.

Bearings, Angular Contact
- Ahlberg Bearing Co.

Bearings, Axle Generator
- Ahlberg Bearing Co.
- Electric Storage Battery Co., The
- S. K. F. Industries, Inc.
- Safety Car Heating & Lighting Co., The

Bearings, Ball
- Ahlberg Bearing Co.
- S. K. F. Industries, Inc.

Bearings, Ball Thrust
- Ahlberg Bearing Co.
- S. K. F. Industries, Inc.

Bearings, Radial
- Ahlberg Bearing Co.
- S. K. F. Industries, Inc.

Bearings, Radial (Single and Double-Row)
- Ahlberg Bearing Co.
- S. K. F. Industries, Inc.

Bords, Rail
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Boxes, Fuse
- Central Electric Co.
- Chicago Fuse Mfg. Co.
- Crouse-Hinds Co.
- Western Elec. Co.

Boxes, Junction and Outlet
- Central Electric Co.
- Chicago Fuse Mfg. Co.
- Crouse-Hinds Co.
- Standard Underground & Cable Co.
- Western Elec. Co.

Boxes, Switch
- Central Electric Co.
- Chicago Fuse Mfg. Co.
- Crouse-Hinds Co.
- Electric Controller & Mfg. Co.
- Western Elec. Co.

Brakes, Crane
- Electric Controller & Mfg. Co.

Brakes, Disc
- Electric Controller & Mfg. Co.

Brakes, Electric
- Electric Controller & Mfg. Co.
- General Electric Co.
- Westinghouse Elec. & Mfg. Co.

Breakers, Circuit Carbon
- General Electric Co.

Breakers, Circuit Oil
- General Electric Co.

Brush Holders
- Anderson Mfg. Co., Albert & J. M.

Brushes, Car Lighting, Generator
- Safety Car Heating and Lighting Co.

Brushes, Motor and Generator
- National Carbon Co.

Brushes, Starting and Lighting
- National Carbon Co.

Cable, Armored and Lead Covered
- Central Electric Co.
- Hazard Mfg. Co.
- Kerite Insulated Wire & Cable Co.
- Okonite Co., The
- Rome Wire Company.
- Standard Underground Cable Co.
- Western Elec. Co.
- York Insulated Wire Works of General Electric Co.

Cable, Insulated
- Central Electric Co.
- General Electric Co.
- Hazard Mfg. Co.
- Kerite Insulated Wire & Cable Co.
- Rome Wire Company.
- Standard Underground Cable Co.
- Western Elec. Co.
- York Insulated Wire Works of General Electric Co.

Cable, Telephone
- Central Electric Co.
- Western Elec. Co.

Carbons, Photographic
- National Carbon Co.

Carbons, Projector
- National Carbon Co.

Carbons, Welding
- National Carbon Co.

Car Lighting Equipment
- (See Lighting, Car Equipment)

Cars, Self-propelled, Passenger
- Sterling Engine Co.

Caustic Soda Cells
- National Carbon Co.

Circuit Breakers
- Cutter Co., The

Circuit Breakers, Air
- Cutter Co., The

Circuit Breakers, Enclosed Car
- Cutter Co., The

Circuit Breakers, Oil
- Westinghouse Electric & Mfg. Co.

Clamps
- Central Elec. Co.
- General Electric Co.

Clamps and Connectors
- Anderson Mfg. Co., Albert & J. M.
- Chicago Fuse Mfg. Co.
- Crouse-Hinds Co.

Compensators, Automatic
- Industrial Controller Co.

Compensators, Manual
- Industrial Controller Co.

Compressors, Air
- Westinghouse Electric & Mfg. Co.

Conduit Fittings
- Central Electric Co.
- Chicago Fuse Mfg. Co.
- Crouse-Hinds Co.
- Electric Controller & Mfg. Co.
- Western Elec. Co.

Conduit, Flexible Metallic
- Central Electric Co.
- Electric Storage Battery Co., The
- Western Elec. Co.

Conduit, Rigid
- Central Electric Co.
- Electric Controller & Mfg. Co.

Connectors
- Ohio Elec. & Controller Co., The

Control Apparatus, Car Lighting
- Electric Storage Battery Co., The
- Industrial Controller Co.
- Safety Car Heating and Lighting Co., The
- Westinghouse Electric & Mfg. Co.

Controllers for Lifting Magnets
- Ohio Elec. & Controller Co., The

Controllers, Automatic
- Electric Controller & Mfg. Co.
- Industrial Controller Co.
- Westinghouse Electric & Mfg. Co.

Controllers, Crane
- Electric Controller & Mfg. Co.

Controllers, Manual
- Electric Controller & Mfg. Co.
- Industrial Controller Co.

Controllers, Machine Tool
- Electric Controller & Mfg. Co.
- Industrial Controller Co.

Copper Rods and Tubes
- Standard Underground Cable Co.

Cutouts, Entrance
- Chicago Fuse Mfg. Co.
- Western Elec. Co.

Electrical Apparatus and Supplies
- Bryant Elec. Co.
- Central Electric Co.
- General Electric Co.
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Electrification Construction Materials
- Westinghouse Electric & Mfg. Co.

Electrification of Steam Roads
- Westinghouse Electric & Mfg. Co.

Electrodes
- National Carbon Co.

Engines, Gas and Gasoline
- Sterling Engine Co.

Fans, Car
- Central Electric Co.
- Safety Car Heating and Lighting Co., The
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Fans, Desk and Bracket
- Central Electric Co.
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Fixtures, Car Lighting
- Central Electric Co.
- Crouse-Hinds Co.
- Safety Car Heating and Lighting Co., The
- Western Elec. Co.

Fixtures, Locomotive Cab Lighting
- Central Electric Co.
- Crouse-Hinds Co.
- Western Elec. Co.

Fixtures, Office, Shop and Yard Lighting
- Central Electric Co.
- Crouse-Hinds Co.
- Western Elec. Co.
- Westinghouse Elec. & Mfg. Co.

Flashlights
- National Carbon Co.
- Western Elec. Co.

Floodlights
- Central Elec. Co.
- Crouse-Hinds Co.
- Western Elec. Co.

Flux, Soldering
- Benson Co., Alex. R.
- Western Elec. Co.

Fuses, Cartridge
- Central Electric Co.
- Chicago Fuse Mfg. Co.
- Western Elec. Co.

Fuses, Plug
- Central Electric Co.
- Chicago Fuse Mfg. Co.
- Western Elec. Co.

Fuses, Refillable
- Central Electric Co.
- Chicago Fuse Mfg. Co.
- Western Elec. Co.

Generators, Axle Driven
- Electric Storage Battery Co., The
- General Electric Co.
- Safety Car Heating and Lighting Co., The

Generators, Car Lighting
- Electric Storage Battery Co., The
- Safety Car Heating and Lighting Co., The

Generators, Power and Lighting
- General Electric Co.
- Pyle-National Co., The
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Generators and Parts, Car Lighting
- Gould Coupler Co.
- Gould Storage Battery Co.

Headlight Reflectors and Cases
- Pyle-National Co., The
- Sunbeam Electric Mfg. Co.

Headlight Turbo Generators
- Pyle-National Co., The
- Sunbeam Electric Mfg. Co.

Headlights, Locomotive
- Pyle-National Co., The
- Sunbeam Electric Mfg. Co.

Headlights, Electric, Repair Parts
- Sunbeam Electric Mfg. Co.

Heavy Electric Traction
- Bridgeport Brass Co.

Insulating Compounds
- Standard Underground Cable Co.
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Insulating Materials
- Central Electric Co.
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Insulators
- Western Elec. Co.

Jars, Battery
- Electric Storage Battery Co., The
- Safety Car Heating and Lighting Co., The

Jars, Rubber
- Electric Storage Battery Co., The
- Safety Car Heating & Lighting Co.

Lamps, Gauge
- Central Electric Co.
- Crouse-Hinds Co.

Lamp Guards
- Western Elec. Co.

Lamps, Incandescent
- Central Elec. Co.
- General Electric Co.
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Lifting Magnets
- Electric Controller & Mfg. Co.
- Ohio Elec. & Controller Co., The

Lighting Equipment, Car
- Electric Storage Battery Co., The
- Gould Coupler Co.
- Gould Storage Battery Co.
- Safety Car Heating & Lighting Co.

Lighting Units, Indoor and Outdoor
- Central Electric Co.
- Western Elec. Co.
- Westinghouse Elec. & Mfg. Co.

Line Material
- Bridgeport Brass Co.
- Central Electric Co.
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Locomotives, Electric
- Westinghouse Electric & Mfg. Co.

Motors, A. C.
- Central Elec. Co.
- Electric Controller & Mfg. Co.
- Howell Electric Motors Co.
- Western Electric Co.
- Westinghouse Electric & Mfg. Co.

Motors, D. C.
- Howell Electric Motors Co.
- Western Elec. Co.
- Westinghouse Electric & Mfg. Co.

Motor Cars, Gas-Electric
- Sterling Engine Co.

BUYERS' REFERENCE

Motor Generator Sets
Ohio Elec. & Controller Co., The
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Motor Starters and Controllers
Anderson Mfg. Co., A. & J. M.
Electric Controller & Mfg. Co.
General Electric Co.
Industrial Controller Co.
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Motors (Fractional Horse-power, A. C. & D. C.).
Ohio Elec. & Controller Co., The

Panel Boards
Chicago Fuse Mfg. Co.
Central Elec. Co.

Panel Board Fittings
Adam Electric Co., Frank.
Central Elec. Co.
Chicago Fuse Mfg. Co.
Crouse-Hinds Co.
Westinghouse Electric & Mfg. Co.

Plugs and Receptacles, Arc Welding
Anderson Mfg. Co., A. & J. M.
Central Elec. Co.
Crouse-Hinds Co.
Western Elec. Co.

Plugs and Receptacles, Battery Charging
Anderson Mfg. Co., A. & J. M.
Central Electric Co.
Crouse-Hinds Co.
Western Elec. Co.

Plugs and Receptacles, Polyphase and Multiple
Anderson Mfg. Co., Albert & J. M.
Central Elec. Co.
Crouse-Hinds Co.
Oliver Electric & Mfg. Co.
Western Elec. Co.

Poles, Accessories
Bates Expanded Steel Truss Co.

Poles, Steel
Bates Expanded Steel Truss Co.

Potheads
Okonite Co., The
Standard Underground Cable Co.

Projectors
Western Elec. Co.

Rectifiers
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Reflectors
Central Electric Co.
Safety Car Heating and Lighting Co., The
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Reflectors, Car Lighting
Safety Car Heating and Lighting Co., The

Regulators, Car Lighting
Electric Storage Battery Co., The
Safety Car Heating and Lighting Co., The

Regulators, Generator
Safety Car Heating and Lighting Co., The

Regulators, Lamp
Safety Car Heating and Lighting Co., The

Repair Parts, Axle Lighting Equipment
Electric Storage Battery Co., The
Safety Car Heating and Lighting Co., The

Repair Parts, Electric Headlight Equipment
Pyle-National Co., The

Signal Accessories
Electric Storage Battery Co., The

Sockets and Receptacles, Lamp
Bryant Elec. Co.
Central Electric Co.
Western Electric Co.
Westinghouse Electric & Mfg. Co.

Soldering Compounds
Benson Co., Alex. R.
Western Elec. Co.

Stops, Electric Limit
Electric Controller & Mfg. Co.

Storage Batteries
Electric Storage Battery Co., The
Safety Car Heating and Lighting Co., The
Western Elec. Co.

Switchboards
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Switch Board Fittings
Chicago Fuse Mfg. Co.

Switch Boxes
Crouse-Hinds Co.
Electric Controller & Mfg. Co.

Switches, Enclosed (Safety)
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Switches, Knife
Central Elec. Co.
Chicago Fuse Mfg. Co.
Crouse-Hinds Co.
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Switches, Remote Control
Electric Controller & Mfg. Co.
Industrial Controller Co.
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Switches, Snap, Push and Pendant
Bryant Elec. Co.

Switches, Time
Anderson Mfg. Co., Albert & J. M.

Tape
Central Electric Co.
Okonite Co., The
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Telephone Apparatus
Western Elec. Co.

Towers, Steel
Bates Expanded Steel Truss Co.

Transformers, Electric Furnace
Lundy Co., E. A.

Transformers, Instrument
Westinghouse Electric & Mfg. Co.

Transformers, Lighting and Distributing
Lundy Co., E. A.

Transformers, Power and Lighting
Lundy Co., E. A.
Western Elec. Co.
Westinghouse Electric & Mfg. Co.

Transformers, Special
Lundy Co., E. A.

Transformers, Street Lighting
Lundy Co., E. A.

Transformers, Welding
Lundy Co., E. A.

Transformers, Transmission Line
Lundy Co., E. A.

Transmission Line Material
Bates Expanded Steel Truss Co.
Lundy Co., E. A.

Wire, Asbestos Covered
York Insulated Wire Works of General Electric Co.

Wire, Bare Copper
Bryant Elec. Co.
Rome Wire Company
Standard Underground Cable Co.
Western Elec. Co.

Wire, Contact
Bridgeport Brass Co.

Wire, Copper Clad Steel
Standard Underground Cable Co.
Western Elec. Co.

Wire, Insulated
Bryant Elec. Co.
Central Electric Co.
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
Okonite Co., The
Rome Wire Company.
Standard Underground Cable Co.
Western Elec. Co.
York Insulated Wire Wks. of General Electric Co.

Wire, Magnet
York Insulated Wire Wks. of General Electric Co.

Wire, Telephone and Telegraph
Hazard Mfg. Co.
Kerite Insulated Wire & Cable Co.
Rome Wire Company.
Standard Underground Cable Co.
Western Elec. Co.

Wire, Trolley
Bridgeport Brass Co.
Rome Wire Company.
Standard Underground Cable Co.

ALPHABETICAL INDEX

Insert shows the *double* cotton covered enameled wire used on all Howell Red Band Motors.

An EXTRA Layer of Cotton Covering Adds 100% to Insulation Durability

Nothing could be more important to the Motor Using field than the fact that *double* cotton covered enameled wire is used in the windings of Howell Red Band Motors; and not ordinary single cotton covered wire. The extra layer of insulation practically doubles its resistance to the deteriorating effects of heat, dust and hard usage.

This is not a mere statement, but a *fact* proven by exhaustive tests made by the Electrical Testing Laboratories of New York. We will gladly send you a copy of their report.

We firmly believe that Red Band Motors will cut your power maintenance costs even down to one-half. Our illustrated catalog gives the reasons. It shows standard and special motors of many types from ½ H.P. to 100 H.P. Write for it.

Howell Electric Motors Company
Howell, Michigan

(51)

Howell RED BAND ELECTRIC Motors

Make Good On The Hard Jobs